

NUTS & VOLTS

M A G A Z I N E



\$3.00

VOL. 15 NO. 11
NOVEMBER 1994

Exploring Electronics And Technology For The Hobbyist And Professional

Escape the world of high-tech
video parlors and build an
"old classic" arcade game!

- Telerobotic Systems
- CCNC 3 Axis Motion Controller
- The X Files
- Ham Radio CD-Roms

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The Tektronix quality, ease-of-use, and serviceability throughout this system were developed to meet strict military specifications (to 65 MHz) and yet allow viewing of signals from 500 μ V to 80 Volts (5 mV to 10 V/div) and 0.2 Hz to 65 MHz accurately (up to 2% of the input). That's 5 nS to 5 S/div.

The 7603N Mainframe (OS-245(P)/U) has the professional styling you've known for years and the versatility of being able to use a wide assortment of plug-ins, allowing the system to grow with your applications. It also has the DELAY function for emphasis of a signal's component. The Horizontal Modes are LEFT, RIGHT, ADD, ALT, or CHOP.

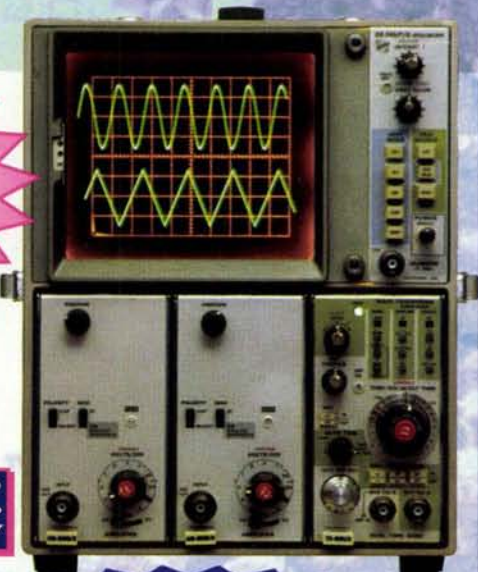
Your system will include two 7A15AN Vertical Plug-Ins (AM-6565/U) to provide you with extra control and an ideal Multiple-Setting Comparator; offering polarity and magnification any way you like. It'll include a 7B53AN Horizontal Plug-In (TD-1085/U) to deliver you the variety of sweeps and trigger capabilities to see signals "just as they are."

Tektronix Quality, Tucker Pricing...Always A Winning Combination!

This is a limited time offer on the free probes and the discount on other plug-ins, so order your system today!

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If resistance is a concern to you, it won't be with a new 673-D! This Milliohmometer is recommended for real world applications where a Kelvin Bridge is too slow and impractical and an ordinary non-linear ohmmeter is too inaccurate and limited in range. You get the best of both instruments with this factory new Shallcross 673-D...speed, accuracy, and range; all in a practical, portable Milliohmometer. Simple to use; connect to the unknown resistance, press the "TEST" button and read the resistance directly from the large easy-to-read scale from 0.005 to 5.0 Ω f.s. (five ranges). Call us now and order your new 673-D and we'll include new accessories not normally included by the manufacturer. You'll receive the easy-to-use Milliohmometer, a fixed clamp with a terminal block and 15' of cable, a pistol-grip exploring probe with a terminal block and 6' of cable, and a 0.0025 Ω precision test standard recommended for use in calibrating and checking all Low Resistance Test Sets. Encased in a sturdy metal case with hinged cover and a battery compartment, this Milliohmometer is ideal for lab, home, or field use. Measures 10" x 8 3/8" x 6 1/2" and requires two No. 6 dry cell batteries (sold separately).

**RS-232 or HP-IB INTERFACE
Most Popular Digital Plotter... Supports Most Software
Hewlett Packard 7475A/001 or 002**



Graphics Plotter

Features two ANSI sizes: 8 1/2 x 11 and 11 x 17 inches, and two ISO sizes: 210 x 297 and 297 x 420 mm. Includes six fiber-tip pens, programmable pen selection with automatic capping. Accepts up to 50 instructions and has 19 character sets; including ISO European standards and Katakana. Available with either an RS-232C (opt. 001) or HP-IB interface (opt. 002). Please specify option when ordering.

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**We Take
Trade-Ins!**



**Classic Generator
Hewlett
Packard
608E
Signal Generator
\$350**

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The HP 608E provides high-quality, versatile performance with distinctive ease of operation due to the analog-meter readout. It offers an adjustable, calibrated output of 0.1 μ V to 1 V rms from 10 MHz to 480 MHz. It allows up to 95% modulation: Internally (600 or 1000 Hz), externally (Amplitude or Pulse Modulation), or Continuous Wave. Basic accuracy of $\pm 0.5\%$. Includes a built-in crystal calibrator which provides calibrated frequency marks every 1 MHz or 5 MHz, your choice. A jack provides an additional uncalibrated radio-frequency output. The crystal's accuracy better than 0.01%.

**Hewlett Packard
34740A/
34702A**

**4 1/2 Digit
Voltmeter
\$99**

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PRE-OWNED
Quality**



The 34740A display locks into the 34702A Voltmeter Module to form a complete DVM System. Using a clear LED display with four full digits plus 100% over-ranging (4 1/2-digits), this system delivers the resolution required by many applications. The front panel is designed to save time and confusion; functions and ranges are clearly labeled and all maximum voltages are indicated at the input terminals. Provides four ranges for both AC and DC voltage (positive and negative 1, 10, 100, and 1000 V full scale) plus six ranges for measuring resistance (100 Ω to 10 M Ω). AC function covers the 45 Hz to 100 kHz frequency range. Call for availability of other meter modules.

***All Test Instruments Include
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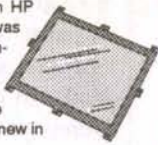
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Thanksgiving values at HSC... ...not a turkey in the bunch!

Ask any engineer or technician in the Bay Area who knows what's what, and you'll find out that they all know about HSC. For over 30 years, we have been offering the best selection of electronic parts, test equipment and exotica at super prices! If you haven't tried us yet, it's time to find out for yourself!

Large-scale LCD

Actually, it's the display screen from an HP laptop (we don't know which one yet). It was made by Epson, it has the Epson part number of ECM-A0234, it measures 7" x 9.25" in display area, with a .75" border, it has a 16 pin header on .1" centers, and it can be yours for only \$24.95! These are factory new in antistatic bags. HSC# 15016 \$24.95



Bargain Ethernet Card

The Ansel Communications NS2104-TB will get you connected! 16-bit ISA bus card works with most leading LAN operating systems such as NetWare and LAN Manager. This particular model is a 4-port hub, with 16-bit Busmaster Software-Selectable Ethernet Adapter for either 10 BASE-2 or 10 BASE-T. These are new-in-the-box units, ready for plug & play, just run your cabling and install the software for configuration. Hurry, limited supply! HSC# 15012 \$39.95

Give your Mac Vision!

With MacVision (and a video camera) your Macintosh will be able to see the outside world! Capture video stills from any composite video source (camera, VCR, video disk) and you can commit a B & W image to a disk file for editing with your paint program. New in the box unit with cables and power supply. Works with Mac II, SE or Plus, System 4.1+ HSC# 80150 \$39.95



NeatBitz...

A. Handy Power Supply #1 -- Beautiful little switching power supply rated at 5VDC, 3A measures 2.75 x 3.25 x 5.25", has standard IEC receptacle for universal (100 - 250VAC, 47 - 63 Hz) input. IEC cord not included, see "C" below. Output is through 6' cord with DIN plug that may be cut off for your own plug to be installed. New in box. HSC#14996 \$5.95



B. Less-Handy Power Supply #2 -- similar in appearance to "A" above, this is a linear supply rated at 12VDC @ 1200 mA, but the input is strapped for 240 VAC input. Use as is with 110VAC for lower voltage output, or open it up and re-strap it for 110VAC use. (Or inquire about our stock of foreign IEC cords to use as is with 240 VAC!) Measures 2.5 x 4 x 6.5", and will need a standard IEC cord ("C" below). HSC#14980 \$5.95

C. Standard IEC Power Cord -- many uses, including powersupplies "A" & "B" above or drive case at left. HSC#80119 \$9.99

D. Network Installation Special -- Dual Terminal Kit. Contains two high-quality ten-foot RG-58 coax cables with BNC's, two BNC tee's, two BNC 50Ω terminators, one BNC coupler. Enough to cable two Thin-net stations to the wall-plate! HSC# 14967 \$9.95

E. VGA to RGB Cable -- Ten foot cable has high-density 15-pin D-sub (VGA type) connector on one end, and 5 BNC connectors on the other: Red, Green, Blue, Horizontal and Vertical synch. Perfect for those high-res CAD monitors! HSC# 14963 \$14.95

F. "Doorknob" Capacitors -- 440pF @ 40KV, made by Murata. HSC# 15021 \$6.95 Some other values available, inquire.

Scanners for Macintosh!

Don't re-type that document into your Mac...don't paint the Mona Lisa with your mouse...just "Scan it" with these handy scanners!

A. 256 Gray Scale Hand Scanner -- SCSI interface, 100 to 400 dpi, eight-bit (256 shades of gray), 4.134 inch scan path. Image enhancement software with customizable tool & filters palette, edge detection, etc. New in box with adaptors, cables, manual & software. Requires Mac SE/30 or II family, 8-bit video card, 2 MB RAM. 90-day warranty. HSC# 14808 \$79.95

B. "Speed Reader" B&W Hand Scanner -- SCSI interface, 100 to 400 dpi, dithered or Black & White modes, 4.134 inch scan path. Handy for scanning halftones, line-art, etc. "MacSee" software is a simple B&W paint program for editing your images. New in box with adaptors, cables, manual & software. Use with your own OCR software (sorry, we don't have any) for text recognition. Requires Mac Classic, SE, LC, SE/30 or II family, 1 MB RAM. 90-day warranty. HSC# 14809 \$49.95



Listen to your Computer!

...with these external speakers by Labtec. Perfect for use with any sound card or personal stereo system, they feature magnetically shielded enclosures, "enhanced bass-response cabinet design", 40 - 16000 Hz freq. response, 3" speakers, 4 watt amplifiers (when 2 C-cells per side are installed) and attractive beige styling. Model CS-550 has bass-boost and treble-boost switches, volume control. These were factory returns, should be OK. HSC#14977 \$9.95



Satisfy your Curiosity!

You've seen them everywhere...department stores, grocery stores, even at HSC! If you haven't wondered what was inside of these little credit card verification terminals, then you are not the normally inquisitive techno-junkie who reads these ads! If your curiosity is piqued, however, then this is your chance to resolve your questions. These used VeriFone Tranz 240 transaction terminals have a vacuum-fluorescent alphanumeric 16-character readout, 12-key keypad, Z-80 processor, CMOS program EPROM, and mag-stripe read-head. Some may have had the mag-stripe read head disconnected, as these were used strictly for keyboard entry, but it should be possible to reconnect it. They were made to communicate with a host computer over a RS-485 line, and use a 8.5 VAC adaptor (sorry, we don't have any of those yet). Quantity discounts available if you are really curious!

HSC# 14848



\$19.95

RF/Microwave Goodies for the High (Frequency) Minded...

We recently received a nice selection of Hewlett Packard RF/Microwave devices for all you high-freq. freaks! The following list is only a partial listing of the thirty or so numbers we have available. We have spec. sheets for all items below, we are attempting to get info on the rest of the parts we have available. Note: The TXV suffix on some of these parts means extra-high reliability (i.e. military/NASA grade), each unit was visually inspected under a microscope before being hermetically sealed.

Cascadable Silicon Bipolar MMIC Amplifiers

Part Num.	Equiv.	Gain	Power	V _{cc}	Bandwidth	Price
HPMA0470TXV	MSA0470	8.5dB/1GHz	12.5dBm/1GHz	5.75 max	3dB:DC to 4GHz	\$8.95

Low-noise NPN Silicon Transistors

Part Num.	Equiv.	Gain	Power	V _{cc}	I _c (mA)	Noise Fig.	Price
HXTR3103TXV	2N6838	15dB/1GHz	21dBm/1GHz	30 max	70 max	1.8dB/1GHz	\$5.95
HXTR6101TXV	2N6617	13.5dB/2GHz		35 max	20 max	1.6dB/2GHz	\$6.95
		9.0dB/4GHz				2.8dB/4GHz	
HXTR6103TXV	2N6618	12dB/2GHz		30 max	20 max	1.8dB/2GHz	\$5.95
HXTR6104TXV	2N6743	14dB/1.5GHz		30 max	20 max	1.4dB/2GHz	\$7.95
QXTR3968	AT41435	14dB/2GHz	19dBm/2GHz			1.7dB/2GHz	\$7.95
		10dB/4GHz	18.5dBm/4GHz			3.0dB/4GHz	

High-gain NPN Silicon Transistors

Part Num.	Equiv.	Gain	Power	V _{cc}	I _c (mA)	Price
HXTR5101TXV	2N6701	13dB/2GHz	23dBm/2GHz	45 max	100 max	\$7.95
		7.5dB/4GHz	22dBm/4GHz			
HXTR5102TXV		11.5dB/2GHz	29dBm/2GHz	45 max	250 max	\$9.95
HXTR5103TXV	2N6741	11dB/2GHz	23dBm/2GHz	45 max	100 max	\$6.95
		7dB/4GHz	22dBm/4GHz			

PIN Diodes

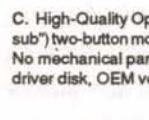
Part Num.	Power Diss.	Residual Resistance	Recovery Time	Cap.	Comments	Price
5082-3001TXV	250mW	1Ω	100nS	.25pF	Gen. Purpose	\$2.95
5082-3168TXV	250mW	.5Ω/100v	12nS	2pF/20V	Band Switching	\$3.95



Pointing Devices Aplenty!



A. Mouse Systems Trackball -- A cluttered desktop need not prevent you from using a decent pointing device for your Windows wandering...use a trackball! No clear space needed for rolling around, it just sits there while your fingertips direct your cursor. 100% Microsoft compatible, uses only 4" x 5.5" of desk space and a serial port. New in box with drivers and software to create custom drop down menus for your "non-mouse-able" programs. HSC# 15009 \$27.50



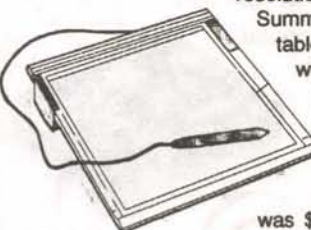
C. High-Quality Optical Mouse (shown at right) -- serial interface (9-pin "D-sub") two-button mouse by Mouse Systems, comes with 7" x 7.75" mousepad. No mechanical parts to wear out or get dirty...no balls to clean! New, with driver disk, OEM version (no book or box). HSC# 14719 \$14.95



D. MacPRO mouse -- three-button Mac compatible mouse by Animas (shown at left). 350 DPI resolution, Apple ADB interface (4-pin Mini-DIN) for Mac II, IIc, IIx, IIx+, LC, SE, Classic, or other Macintosh computer with ADB port. Programmable "cdev" allows full programmability for all three buttons. You even get a paint program called Colorframe (included on driver disk). New in box with manual, mouse-mat, 90 day warranty. HSC# 14718 \$19.95

Sketch like a pro with HP SketchPro!

It's back, and at a lower price...the 7060A SketchPro by Hewlett Packard! It is a medium-format (11" x 11") digitizing tablet with up to 1219 lines per inch resolution, accurate to within .02" and can emulate Summagraphics Bit Pad 2 and Hitachi HDG1111B tablets. This allows the SketchPro to be used with most of the popular CAD and graphics programs, such as AutoCAD, Versa CAD and CADKEY. We are offering a brand-new-in-the-box tablet with pen-type pointing device, substitute power supply and documentation for only \$109.00 (list price was \$599). A four-button "puck" type cursor is available directly from HP if you prefer that type of input device. We are offering a 90-day warranty on this high-quality U.S. product. Note: you will need to make a special serial cable for this device to work properly, connection diagram included with documentation. HSC#14739 \$109.00



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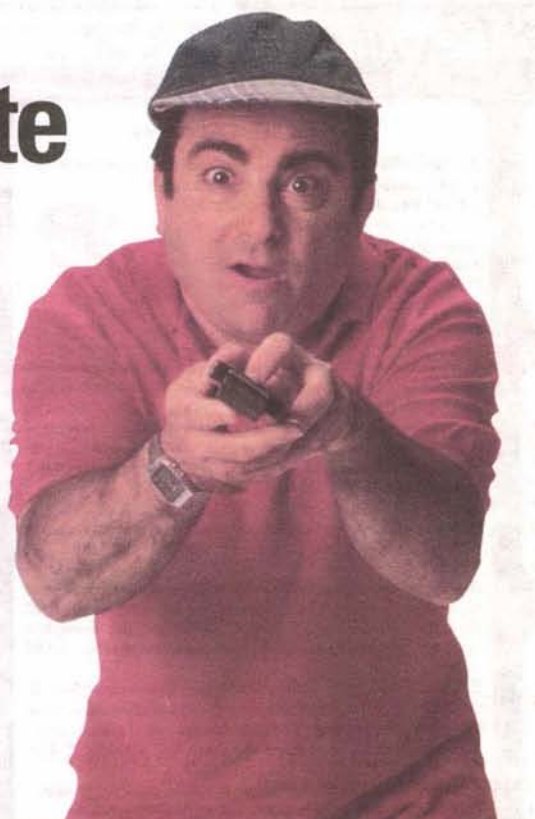
(707) 792-2277



Put the remote back into your remote control!

Amazing new device attaches to your existing remote control giving it the power to transmit anywhere, even through walls!

By Charles Anton



It's Thursday evening and you have dinner guests. The kids are watching TV but it's too loud. Without embarrassing yourself or the kids by yelling to turn it down, you pick up your remote with Leapfrog long range power and turn it down without a hassle.

Until now remote control has never been very "remote." Even with the best equipment you had to be right in front of your stereo, TV, VCR, etc. to make it work. Now you can operate your entire entertainment system from anywhere in your home with Leapfrog, the next generation in remote systems.

How "remote" is it?

Imagine yourself at home enjoying a relaxing evening of movies on your VCR. You decide to stop the movie so you can get yourself a snack. You aim the remote and click, but nothing happens! You grow more and more irritated, and finally have to stand right in front of the VCR before you can get it to stop the movie. You find yourself wondering why they call it a "remote" in the first place.

Why all the hassle?

Typical remotes use infrared technology. In order for the process to work, the remote must be in direct line-of-sight with the audio-visual equipment. The equipment must "see" the signal.

Radio revolution. The Leapfrog transmitter never needs to be perfectly "lined-up" with the TV, etc. Why? Because the transmitter doesn't rely on an infrared signal. You can even point it in the wrong direction and it still works. Leapfrog overcomes all the headaches of obsolete remote controls through the use of radio waves.

Radio waves work anywhere within a 150 foot range. The signals pass through walls, doors, ceilings and floors, letting you control your equipment from any room of your home. You cannot aim and miss.

Infrared to radio.

The Leapfrog transmitter, which attaches to your existing remote control, sends radio signals to the Leapfrog receiver. This receiver then transmits the signal to your audio-visual equipment with infrared technology.

Versatile uses.

This amazing new remote control modifier works with any infrared remote. Just imagine the convenience of controlling your VCR, TV, stereo, cable converter box, speakers in multiple rooms, or any other audio-visual system throughout your home.

Leapfrog is also ideal for use with universal remotes. Control it all with just one remote.

How does Leapfrog work?

Leapfrog converts your infrared remote signal to radio frequency. Radio frequencies enable the signals to pass through walls and other obstacles. It also allows signals to transmit up to 150 feet without staying in line-of-sight with your equipment. Leapfrog then re-transmits the signal to the receiver, which forwards it to your audio-visual equipment.

Leapfrog installs in minutes. The transmitter attaches to your current remote. Plug the receiver into any outlet and place it in line with your audio-visual equipment.



Talented remote.

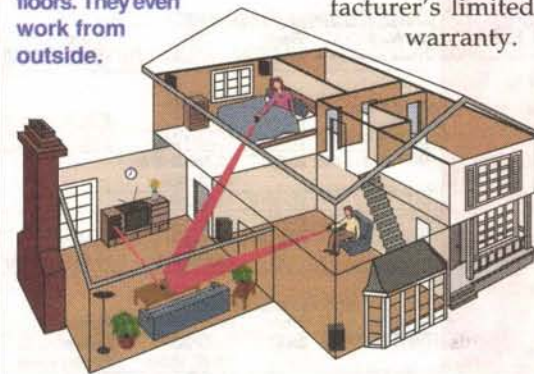
The Leapfrog is not another hand-held remote control. This powerful innovation actually modifies your current remote, thus enhancing its value. You can control your stereo, your VCR, your TV, etc. from anywhere. From across the room or from across the house.

You can even use Leapfrog from outside. This is a fantastic feature to have when you're out by the pool, on your patio, or in your garage.

Factory direct. You would expect an innovative device like this to cost several hundred dollars. That might be the case if we sold only through exclusive high-end audio-visual dealers. But we bring the good news straight to you. You save money with factory direct prices.

Try it risk free. We are so confident that you will love Leapfrog that we've backed it up with our "No Questions Asked" 30 day money-back guarantee. If you are not completely satisfied for any reason, just return it for a full refund. Plus, it comes with a full one year manufacturer's limited warranty.

Leapfrog transmits signals in a range of up to 150 feet. Signals actually pass through walls, ceilings and floors. They even work from outside.



Leapfrog Remote Range Extender \$79 \$6 S&H

Please mention promotional code 192-NV-1107.

For fastest service call toll-free 24 hours a day

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To order by mail, send check or money order for the total amount including S&H (VA residents add 4.5% sales tax.) Or charge it to your credit card, enclose your account number and expiration date.

COMTRAD INDUSTRIES

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Why Leapfrog beats infrared

■ **Range.** You can control electronics from up to 150 feet away.

■ **Aim.** You can't miss. Point your remote in the wrong direction and it'll still work.

■ **Value.** It lets you get the most out of your audio-visual equipment by making use of it throughout your home.

■ **Flexibility.** Because it sends signals through barriers, it lets you store your equipment behind cabinet doors.



NUTS & VOLTS MAGAZINE

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EDITORIAL CONTRIBUTIONS

Nuts & Volts Magazine encourages article submissions and queries.

Send a SASE for a copy of our writer's guidelines.

All submissions should be on 5-1/4 or 3-1/2 inch diskettes and include hard copy as well. If return of materials is requested, include a SASE with your submission.

Deadlines should be discussed in advance with the editor, but generally all material should be submitted by the 1st of the month for the next month's issue.

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If you are moving, notify us AS SOON AS POSSIBLE so we can continue your subscription without interruption.

Your magazine WILL NOT automatically be forwarded to you by the post office, so it's important to submit your change of address directly to Nuts & Volts.

We will not be able to replace missed issues of the magazine due to unreported address changes.

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reader FeedBack

Dear Nuts & Volts:

The September article entitled "Build a High-Sensitivity Carbon Monoxide Gas Detector" greatly disturbs me. First, the article incorrectly stated the OSHA guidelines for carbon monoxide exposure as 50 parts per million (ppm), which the author states as being "safe." This standard has been lowered twice; first to 20 ppm and more recently to 10 ppm which is now considered "safe." For Canadian readers, the limit is only 5 ppm. The standards are provided by OSHA, NIOSH, and The American Industrial Hygiene Association.

Also, to term the Figaro TGS-203 as a "High-Sensitivity" sensor of "relatively new technology" is far from true. In my field, the term "High-sensitivity" means accurate detection below 10 ppm with response times of 35 seconds or less and real-time monitoring. The Figaro set is rated to respond above 50 ppm and at 2.5 minute intervals; very old technology by today's standards.

Another greatly disturbing section of the article was the suggestion to

manufacture carbon monoxide at unknown levels rather than purchasing limited quantity carbon monoxide from a scientific source for calibration. Controlling a 1.7 liter bottle of 50 ppm carbon monoxide/balance air is far less risky remembering carbon monoxide is poisonous. I also highly discourage the use of a flammable cross-sensitive gas such as propane. After all, every work bench has electricity and hot soldering irons which can lead to a very dangerous situation.

I have written to Anthony Charlton, author, to inform him of the potentially lethal situation he and his article has placed your readers in.

Tom McDonald
Electronics Engineer/Gas
Monitors
Milton, WA

Dear Nuts & Volts:

I was amazed at the feedback letter by Mr. John Winslow in the July '94 issue. More particularly, I was surprised that you would print such a collection of misinformation, since

your tutorial style seems to be aimed at educating readers, not misleading them.

Since I am a new subscriber, starting with the July issue, I have not read the April '94 "answer" by Mr. Uhrig, which prompted Mr. Winslow's letter. In any context, however, many of Mr. Winslow's statements are technically unsupportable (i.e., flat wrong), to wit:

The beginning statement about 2 dB gain improvement being "not discernible, by the human ear": A general statement about hearing, not antennas. Perhaps he has never struggled for a gratifying 2 dB improvement of a low signal-to-noise ratio.

His assertion that antenna gain is not a function of antenna pattern: A discussion of directivity, power gain, effective area, patterns, and their fundamental interrelationships would demonstrate otherwise.

The statement, "the gain is a function of RF energy being fed into the antenna": Not so. Antenna gain is independent of power (and energy) level. A lower VSWR will indeed reduce mismatch loss, but that does not result from higher power (or energy).

While other statements and implications are in error, these examples suffice. My purpose is not to demean Mr. Winslow, but rather to support my contention that editorial decisions about letters should favor

your subscribers. Letter-writers (including this one) are not perfect and we sometimes misspeak or oversimplify. But egregious errors of fact should be omitted or annotated.

After 35 years as an electronics engineer, I still enjoy the hobby, as I expect to enjoy your magazine. I look forward to the next issue.

Ed Carrell
Round Rock, TX

Dear Nuts & Volts:

Firstly, I would like to thank you for the complimentary issues that you send me from time to time.

I thoroughly enjoy the entire magazine, especially the projects articles. I am employed as an electronic technician for the Postal Service and also do electronics work as a hobby.

In your Oct. 94 issue there is an article on page 18 by Walt Noon where he describes the construction of an audioanimatronic device, he mentions the use of two hard-to-find motors, and states that if the reader cannot find these motors locally, he will sell them to the reader.

He references his address at the end of the article to write to. I can find no such listing of an address and I wish to purchase two each of his motors. Could you please supply me with his address and possibly have him reserve two each of those motors for me?

Lance Watson
Reading, MA

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Last month, as many readers have pointed out, the address for Walt Noon was inadvertently left out from his Audioanimatronics article.

For those readers wishing to contact Walt, he can be reached at:

**3283 Belvedere,
Riverside, CA 92507**

Walt is the author of *Secrets of Electrostatic Lightning Bolt Generators, Build Your Own Solar Cells, and Build a 40,000 Volt Induction Coil.*

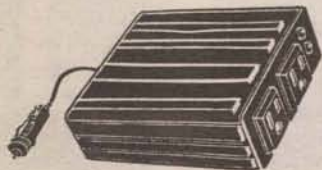
His animatronic creations are available year round for fund raising events and to provide entertaining haunting for your organization.

We would also like to acknowledge Gail Johnson for her fine photography work used in the article.

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10

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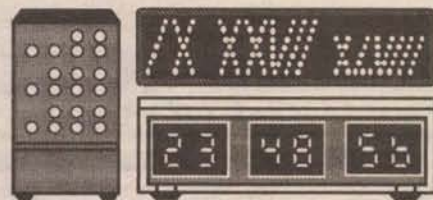
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Nuts & Volts Magazine/November 1994 7

Cimple Computer Numerical Control

by Dan Mauch

Three-Axis Motion Controller

In last month's article, the concepts of Cimple Computer Numerical Control were discussed. In this article, we will assemble and test a simple, yet powerful, three-axis motion controller. This controller will be used with a shareware Computer Aided Manufacturing (CAM) program that reads the data from a Computer Aided Design (CAD) file.

The controller is capable of running a variety of small CNC machines such as a circuit board drill, horizontal bandsaw, or wire measuring and cutting machines. It can be used to automate a task, run a robotic arm for pick and place, or animate art or sculptures.

CONSTRUCTION

Begin by studying the photographs and schematic diagrams.

1. Cut and install 20 AWG wire jumpers J1-J12.

2. Solder each connection using a 25-35 watt soldering iron with a fine point.

3. Install R1-R10 2.2K 1/4 watt resistors. Solder each connection.

4. Install the three 16-pin DIP solder tail sockets making sure that the notch on the socket is orientated to line up with pin 1 of IC1-IC3 on the

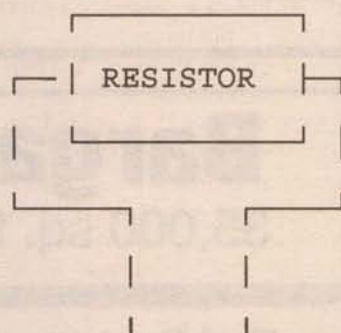
circuit board.

Solder each connection.

5. Install D1-D12 1N5817 diodes. Ensure that the silver band faces the socket for proper orientation. Solder each connection.

6. Install the DB25 right angle PC mount male plug and solder the connections.

7. See the section on current limiting resistors before accomplishing this step. Bend the leads of the power resistors as shown in the sketch then install and solder each connection.



Be sure to use adequate heat to ensure a good bond between the lands and the leads.

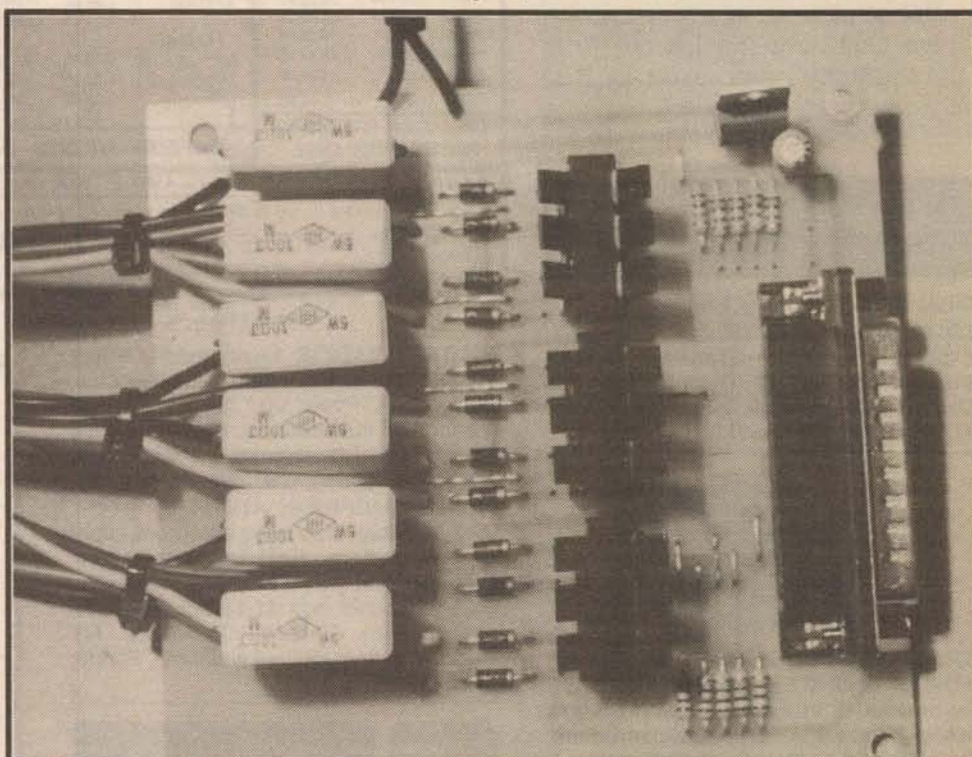
8. Strip 1/8" of insulation from the 18 pieces of 12" long 18 AWG stranded motor connector wires. Solder each wire using the

correct color for each connection. See the illustration for placement. Ensure there are no loose strands that can short to adja-

cent wires.

9. Secure each motor wire bundle with a tie wrap or electrical insulating tape.

10. Cut all wires to the same



Parts layout and jumper wires for three-axis controller. Note that the power resistors are raised 1/4" above the circuit board and all wires are tie wrapped for strain relief.

N/C DRILL FILE TO DRILL YOUR OWN CIRCUIT BOARD

M48

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T04F00S00

T06F00S00

T08F00S00

%

T02

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X00425Y005

X00545Y0061

X0064Y00378

Y005

Y0061

X0074Y00378

Y0061

X0084Y00378

Y0061

X0094

X0064Y0101

Y01112

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X0084Y0101

Y01112

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X0104Y0101

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X01138Y0041

X0059Y01656

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Y02201

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X0069Y02038

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X00829Y02488

X01495Y0201

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X01795Y0201

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X02115Y02213

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X0064Y01327

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X0299Y02945

X0263Y0259

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X0263Y021

Y0232

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X0263Y0159

Y0181

X02985Y0145

X0262Y01105

X0263Y0132

X02985Y00945

X02625Y006

X0263Y00815

X02985Y0045

X02855Y0015

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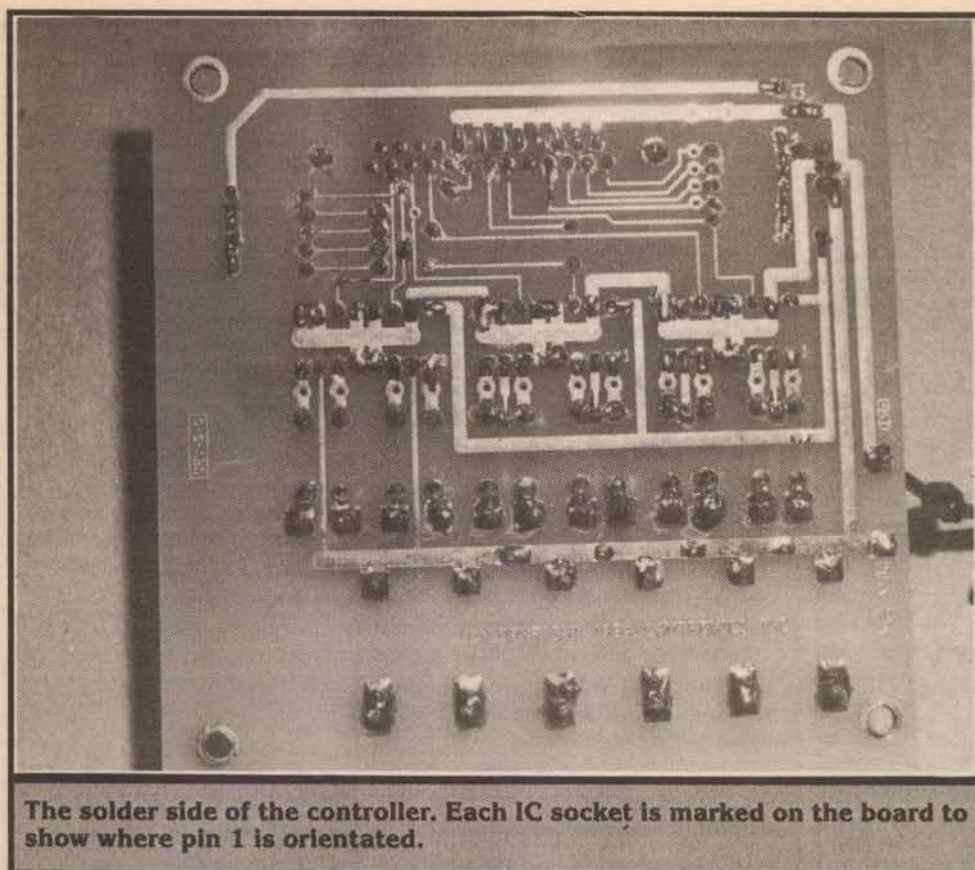
X002Y002

Y038

X038

Y002

M30



length. Strip 1/8" of insulation on the connector side of each wire and, using the proper crimping tool, crimp the molex female pins onto each wire. Insert each pin into the male socket as shown:

1 = orange	V	V
2 = black	10	30
3 = yellow		
4 = green	40	60
5 = black		
6 = red		

Note: You may reconfigure the pins on this connector or the stepper motor to match up with the proper phase as desired.

11. Strip, insert, and solder the wires for the 12 VDC power connections.

12. The X-Y-Z Home and the Range connections are similar to those above except that the X-Y-Z and range switch connections use 22 AWG stranded wire. Use a connector between the controller and the Home/Range switches. Wire the connector using the schematic for guidance.

13. Install the 78MC05 voltage regulator and the 10 μ F capacitor. Ensure that the orientation of C1 and the 78MC05 is correct.

At this time, a couple of simple modifications may be made to the PC board for a fan motor connector and solid-state relay inputs.

14. Install a polarized two-pin connector for a fan. Use 20 AWG solid wire. Bend and solder the connections at the circuit board and the connector ensuring that the + and ground are correctly orientated for correct fan rotation.

15. If solid-state relays are to be added at a later date, solder 22 AWG stranded insulated wires to pins 5 and 9 of the DB25 connector on the circuit board. A signal ground lead is required from pins 18-25 which is connected to the - of the solid-state relay.

At this point, the basic controller is complete.

CHECKOUT

1. Clean the solder side of the board using a stiff nylon brush and Isopropyl alcohol (rubbing alcohol).

Let dry. Do not connect to your computer until directed.

2. Inspect for solder bridges, shorts, loose strands, and cold solder joints. Correct if necessary.

3. Install IC1-3 with heatsinks observing anti-static protection procedures. Ensure that the notch for pin #1 of the ICs is matched to the notch on the 16-pin DIP socket.

4. Insert a six-amp fuse in the fuse holder. Connect the 12 VDC power connector to the power supply.

5. Measure the voltage output from the voltage regulator and ground. It should measure 5 VDC \pm 0.1 volt. If 0 volts, check the 78MC05 for proper orientation and good solder joints.

6. Measure the voltage at pins 2, 3, 4, 6, 7, 8, 10, 11, 12, 13, and 14. They should measure 5 VDC \pm 0.1 volt. If less than 4.9 V, check solder connections at the pull-up resistors, jumpers, and the DB25 connector for shorts or cold solder joints.

7. Measure voltage at pins 1, 5, 9, and 15-25. There should be 0 VDC. Looks for shorts or incorrect jumpers if any voltage is present.

8. Measure the voltage at pin 16 of IC1-3. It should read +5 VDC \pm 0.1 volt. If less than 4.9 V, check to ensure the jumper J7 is installed and all power connections and components are correctly orientated and soldered properly.

9. Install the controller circuit board in a metal computer power supply case similar to that shown in the photos using metal standoffs. It is essential to have a cooling fan and a metal case for safety, and to dissipate

the heat from the power resistors and ICs. Use grommets to protect wires from sharp metal edges.

OPERATION

WARNING: Since the controller does not use optoisolators on the inputs, there is a remote possibility that something could go wrong and cause damage to your parallel port or computer. Therefore, you should install an optoisolator between your parallel port and the controller.

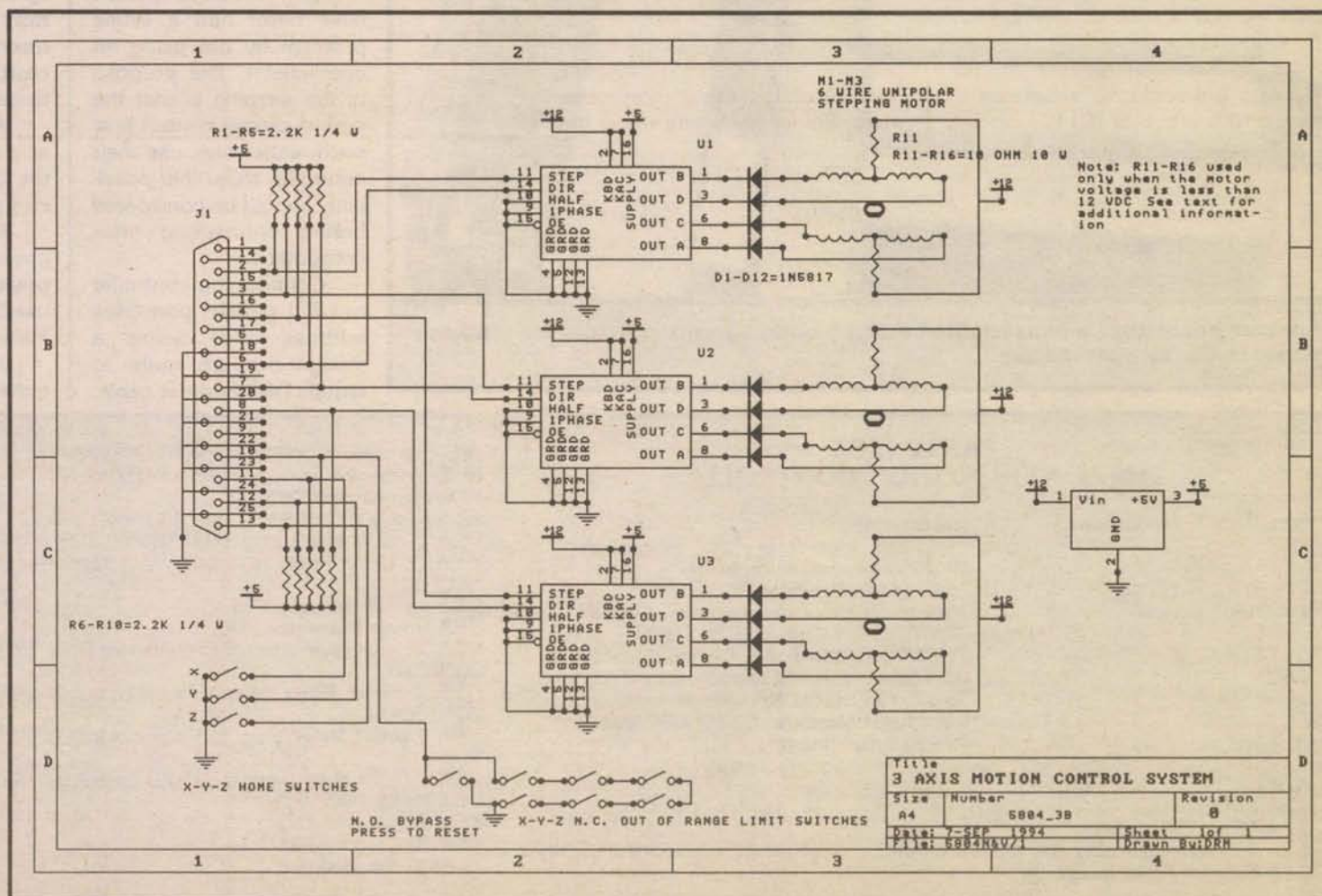
SOURCES

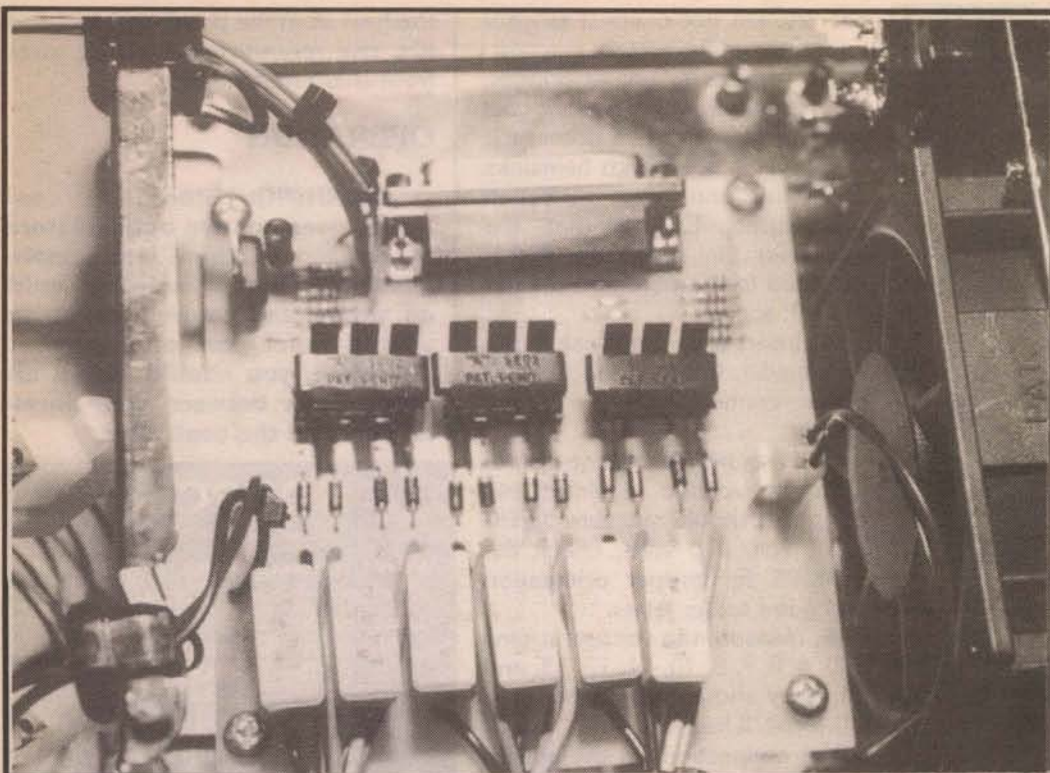
With the exceptions of the printed circuit board, ICs, and inline fuse holder, all parts are available from Mouser Electronics (800) 34-MOUSER.

The following parts are available from CAMTRONICS INC.:
Complete controller kit \$85.00 without enclosure.
PC board \$15.00.
IC1-3 \$7.50 each.
Enclosure with fan \$10.00.
DANCAD3D/DANCAM shareware \$15.00 for six-disk set.

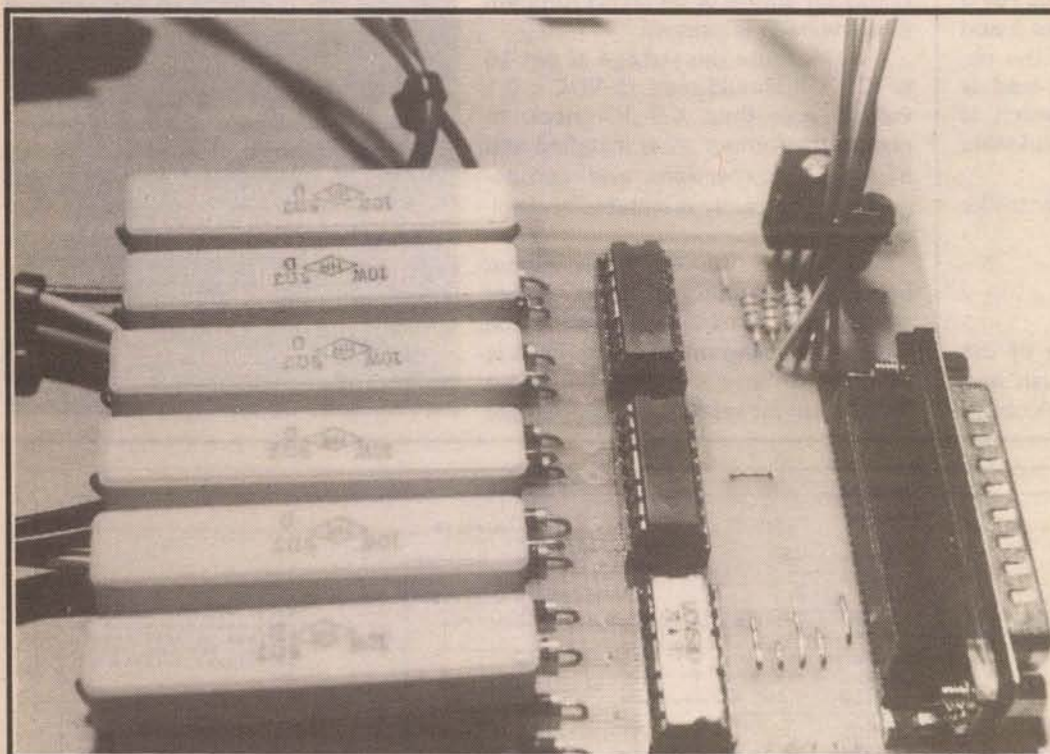
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The completed circuit board mounted in a metal power supply case with a cooling fan for safety and to dissipate the heat of power resistors and ICs. Note the modification that adds a connector for the 12 VDC fan motor. The connector is wired directly to the power traces on the bottom of the board.



Another board that was assembled using 5-ohm, 10-watt resistors for maximum power to the stepper motors.

STEPPING MOTOR CURRENT LIMITING SERIES RESISTORS

The three-axis motion controller can provide more current than some motors were designed to handle. If the current provided is greater than the motor rating, one or more of three things will occur:

1. The motor windings will burn out.
2. The motor will get very hot.
3. The excessive current will shorten the life of the stepper motor and the motor will demagnetize.

To prevent this from occurring it may be necessary to change the values of R11-R16 from the 10-ohm, 5-watt resistor to another value that will limit the current to a safe level. The formula for determining the series resistor is $R_b = V_s - 1 - V_m / I_m$.

R_b = The value of the series resistor.

V_s = The voltage of the source power supply.

1 = The voltage drop across the diodes and driver.

V_m = The voltage rating on the motor.

I_m = The current rating of the motor.

Thus, with a 12 V power supply and a 5.7 V motor with a current rating of .88 amps per phase, $R_b = 12 - 1 - 5.7 / .88$.

$R_b = 6.82$ ohms.

To reduce the current below the motor rating, if so desired, the value of R_b may be safely increased. Substitute the proposed current rating (I_m) and solve the equation for new values of R11- R16.

Next, the wattage of the power resistors must be calculated using a simple formula. $W = (V_s - V_d - V_m) * I_m$

W = The value of the resistor in watts.

V_s = The supply voltage.

V_d = The voltage drop.

V_m = The rated voltage of the motor.

I_m = The current rating of the motor.

Thus, for the above motor $((12 - 1 - 5.7) * .88 = 4.664$ watts.

Or, you may do what I have done and use old XT/AT computers that can be bought at swap meets at a very low price.

On the other hand, I have never had a single problem by not using an optoisolator. The purpose of the warning is that the author cannot control how each reader may use their controller thus, this possibility should be considered before connecting your computer.

Connect the controller to LPT1 parallel port (Hex address 378) using a straight-through male to female DB25 printer cable.

WARNING: Never turn on the computer with the controller connected to the power supply. As the computer boots, solid-state relays may inadvertently activate spindle motors or stepper motors may move the mechanism in an uncontrolled manner. Read the cautions in the DANCAM document file before use.

After the computer is turned on and at the C prompt, select and load the DANCAM (see last month's article) program.

Connect the 12 VDC, 8 ampere power supply (a 200 watt computer power supply or battery may be used) and turn on the controller. Make sure the cooling fan is running.

For the initial test of the controller, connect one stepper motor at

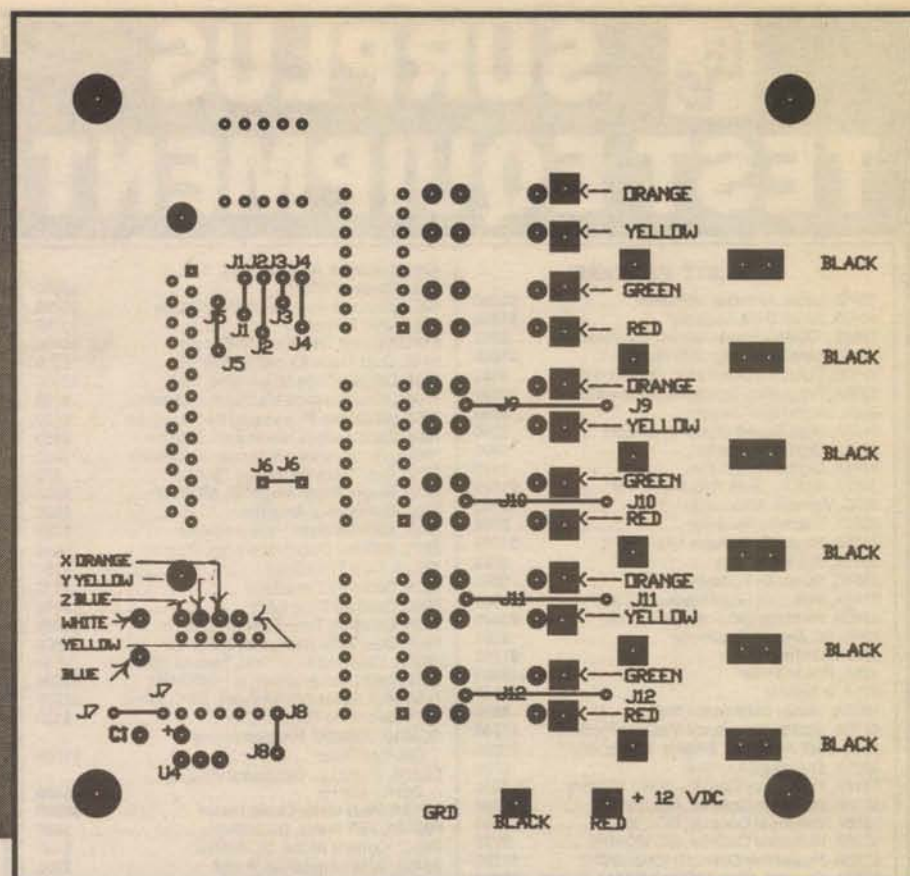
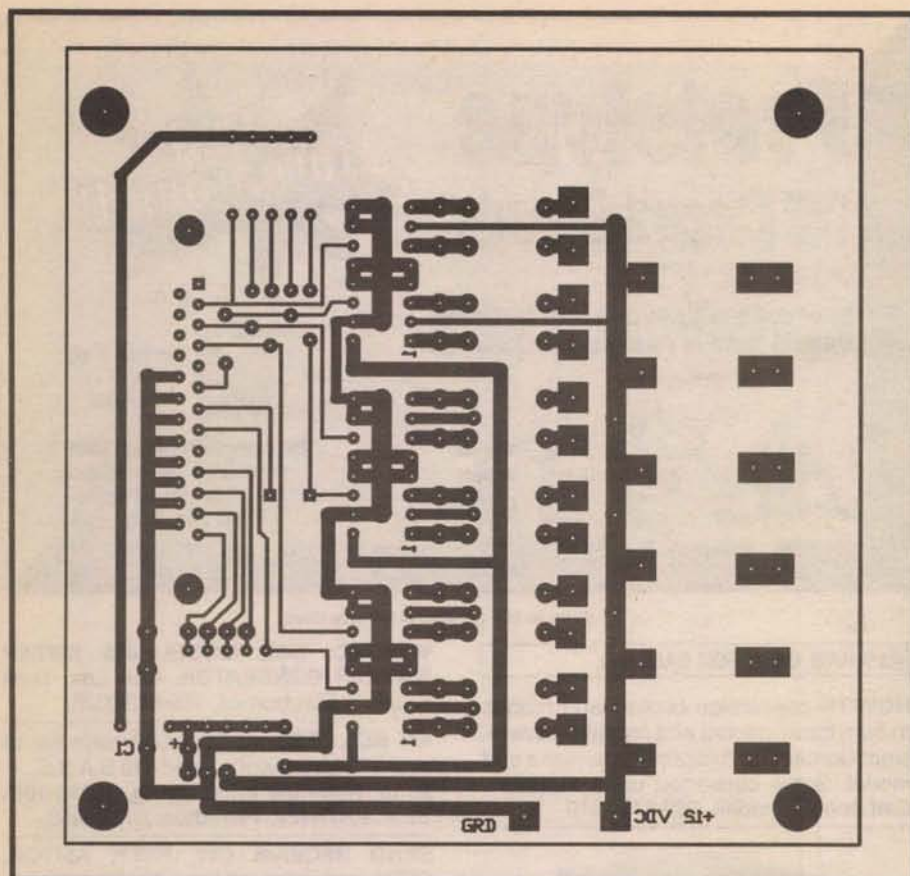
PARTS LIST THREE-AXIS MOTION CONTROLLER

Part	Quantity	Description
P1	1	DB25 right angle male plug — PC mount
C1	1	10uf 25V electrolytic capacitor
R1-R10	10	2.2K 1/4 watt resistor 5%
R11-R16	6	10-ohm, 5-watt sandstone power resistor.
(* READ SECTION ON CURRENT LIMITING*)		
D1-12	12	IN5817 Schottky diodes 1 Amp 20 volts
U1-U3	3	UCN-5804B unipolar stepper motor T/D
U4	1	78M05 +5 VDC 500MA voltage regulator
F1	1	Inline fuse holder with 6 AMP AGC fuse
PC-1	1	Printed circuit board

MISC.

- 3 EA DIP heatsinks
- 3 EA 16 pin DIP sockets
- 3 EA 6 circuit Molex plug .093 CONNECTORS, (STEPPER MOTOR CONNECTOR)
- 3 EA 6 circuit Molex receptacle

- .093 connector (CONTROLLER TO STEPPER)
- 18 EA male pins .093 (STEPPER MOTOR)
- 18 EA female pins .093
- Jumper wire (PC BOARD) solid 18 AWG
- 1 EA 2 circuit Molex plug .093 CONNECTOR (POWER SUPPLY)
- 1 EA 2 circuit Molex receptacle .093 connector (CONTROLLER TO POWER CONNECTOR)
- 2 EA male Molex pins .093
- 2 EA female Molex pins .093
- 1 EA 3 circuit Molex plug .093 connector (CONTROLLER TO OUT OF RANGE CONNECT.)
- 1 EA 3 circuit Molex receptacle .093 connector (OUT OF RANGE SWITCH(S) TO CONTROLLER)
- 1 EA 4 circuit Molex plug .093 connector (CONTROLLER TO XYZ HOME CONNECTOR)
- 1 EA 4 circuit Molex receptacle .093 connector. (XYZ HOME SWITCHES TO CONN)
- 4 EA MALE PINS .093
- 4 EA female pins .093
- 18 AWG stranded wire
- 22 AWG stranded wire



a time with an amp meter in series with the +12 VDC power lead.

Note that there will be a magnetic brake on the stepper motor and it should not turn unless significant torque is applied to the shaft. This is normal.

Measure the current. With two phases on the motor, it will draw about 1.3 amps with the resistors supplied in the kit.

RUNNING DANCAM

1. The three-axis controller was specifically designed to run three stepper motors on DANCAM. It will also run on user-developed software as long as the step and direction pulses are fed to the correct pins.

2. NOTE: DANCAM will give an error if the OUT OF RANGE switch is open or not connected. If this feature is not to be used at this time, then it will be necessary to JUMPER THE YELLOW AND BLUE WIRES FROM THE CONTROLLER TO THE THREE CIRCUIT CONNECTORS. The error message provided by DANCAM will now disappear.

3. Load DANCAM.

4. From the main menu, select #4 and hit Enter. The program will ask: "Change the Dancam.cfg configuration file to adjust how the motors move"

5. Next, from the installation menu, select #1. A new menu will pop up.

6. From the parallel port menu, enter the motor drive board type. The default is "0." Press Enter.

7. On this same menu after the "0" is typed, it will ask you to enter the parallel port to use. Normally, you would enter LPT1. (If the controller board doesn't work with this setting, you might have a Hercules monochrome video adapter with the wrong port address. You may have to buy a

\$20.00 parallel port board configured to run on hex address 378. LPT2 or LPT3 may be used if supported by your hardware.

8. Enter the # of pulses per motor request. This is always 1. Press Enter.

9. The main installation menu will now appear. Select #2 — Motor pulse width factor test and install commands.

10. A new menu will pop up. With the parallel port cable connected to the three-axis controller, the three stepper motors connected to the controller, and 12 VDC power supplied to the controller, Press 1.

11. An installation instruction will ask what motor axis to test (X, Y, or Z) Select X. Then press Enter.

12. Another instruction will pop up and will request the PULSE WIDTH FACTOR. A table is provided on screen to give help. The default is 600. When you press Enter, the X axis stepper motor will run forward and backward. If the motor seems weak or just chatters, press S to slow it down until it runs strongly (about 1900 pwf on a 386-25). If it is slow but strong, then try speeding it up by pressing F on the keyboard. Press control X when satisfied.

13. If you get a "SERVO MOTOR ERROR" or "LIMIT SWITCH IS OPEN" message, make sure that the out of range switch is in the correct position or temporarily jumper the yellow and blue wires at the connector.

14. Set the PULSE WIDTH FACTOR for the Y and Z axis similarly.

15. Press Escape until you are back at the main menu. The program will record the current configuration every time it goes to the main menu. So, if you make any temporary changes, make sure you change the values back to the original. Better yet, make a copy of DANCAM.CFG file and store it separately for use if the installed copy is corrupted.

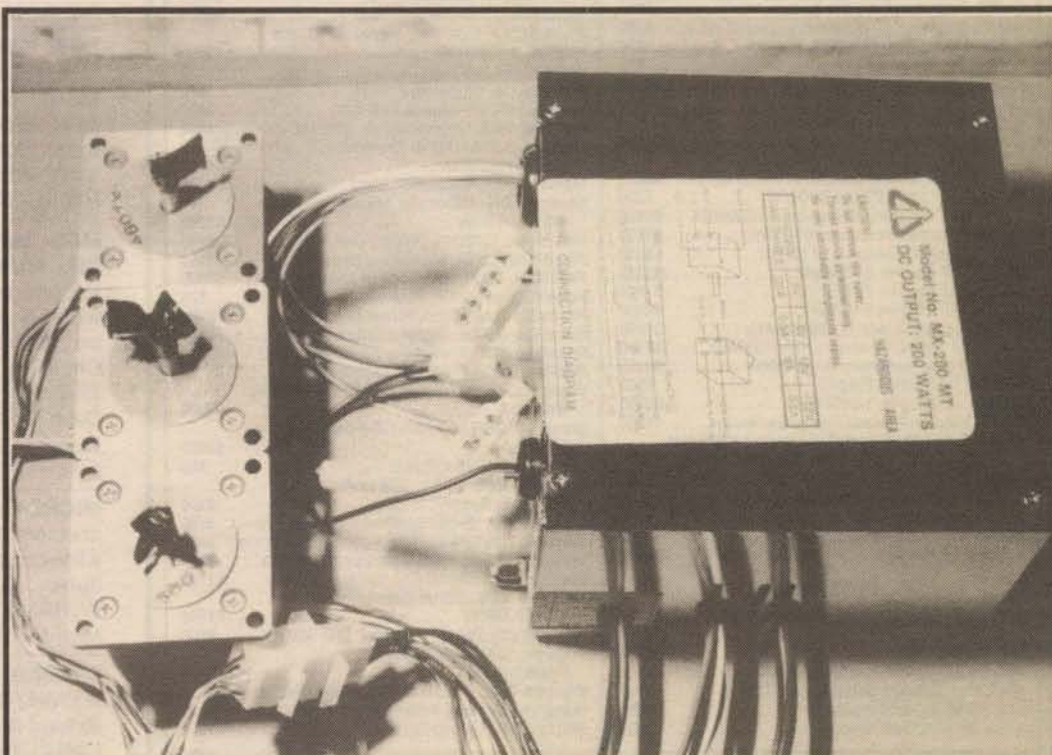
16. A data file called 1857.drl is included in the kit. At the main menu, enter 1 to select a DANCAM file to be read. A new screen will pop up. Enter the path and file name i.e., C:\temp\1857.drl. The program will try to home up the motors if the hon/me set-up menu was set to ON. If you don't have home switches, go

back and shut the feature OFF for now. Rerun the 1857.drl file and you should see the three motors moving to the commands of the data file.

17. Always shut off the controller when not in operation.

18. Read the DANPLOT.DOC file in the DANCAM diskette for many other features and a detailed explanation of other uses for DANCAM/DANPLOT program. Be sure to read the safety warnings and conditions for use of the program. Once you get up and operating, you will find that DANCAM is a superb program for the price.

In next month's article, a simple machine will be constructed using the techniques of CCNC and the controller constructed in this article. NV



The completed controller installed in a gutted 200-watt computer power supply case. All wires coming out of the case have grommets to protect against chaffing. The stepper motors have a piece of tape on the motor shaft so that their movement may be more discernable. The unit is ready for testing.

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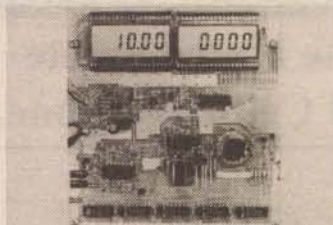
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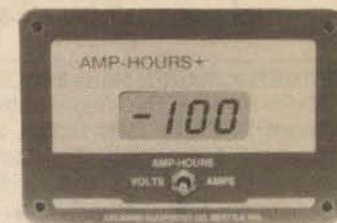
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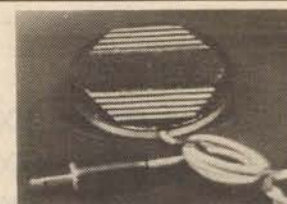
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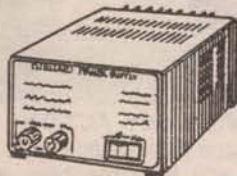
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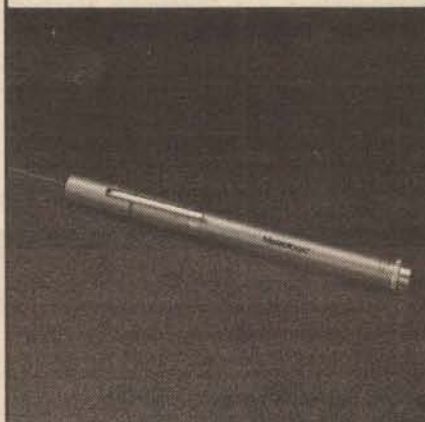
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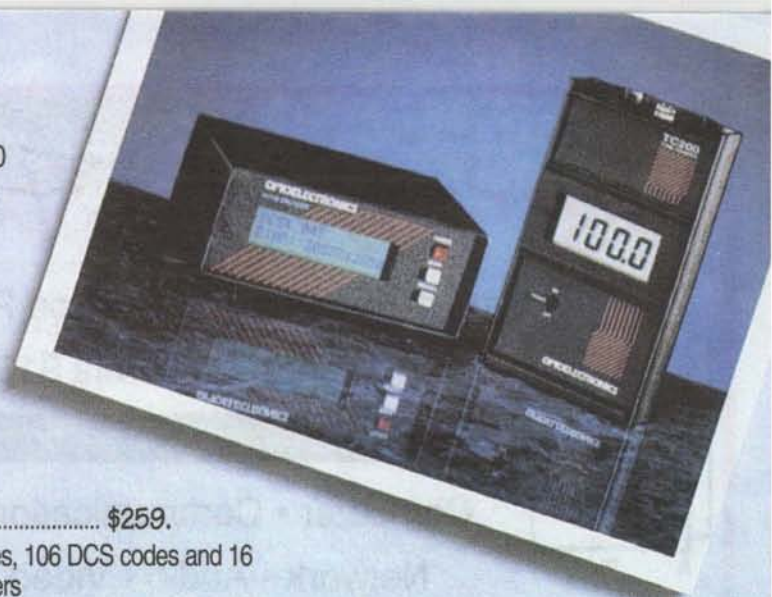
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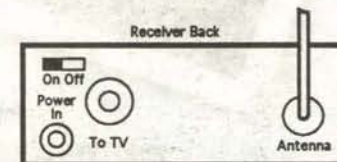
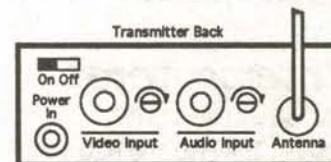
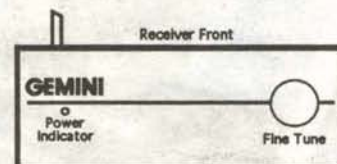
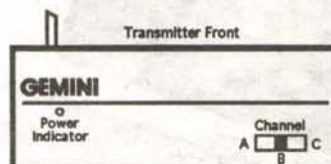


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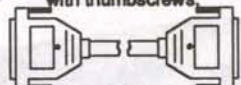
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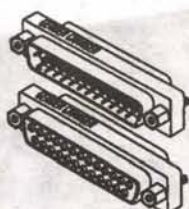
DB25 to 36 Pin Centronics
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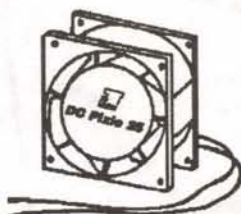
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#GC-15M-2	DB15	\$3.00
#GC-25M-2	DB25	\$2.50
#GC-36M	Cent. 36	\$6.00
#GC-37M-2	DB37	\$5.00
#GC-HDM	HD15 VGA	\$5.00
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Slim Line Female

#GC-09F-2	DB9	\$2.00
#GC-15F-2	DB15	\$3.00
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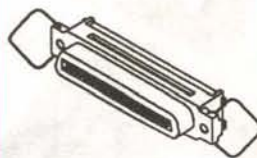
12 VDC



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Centronics IDC Connectors



Male

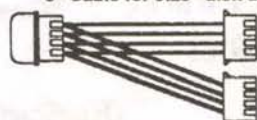
#CN-681	50 pin SCSI	\$3.00
#CN-545	36 pin parallel	\$2.00

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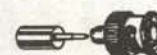


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\$1 each

#CC-DRY
\$1.50 each

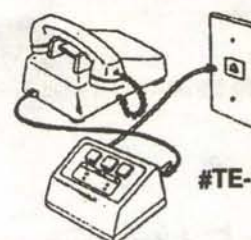
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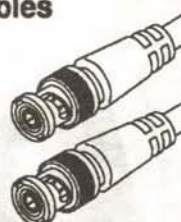
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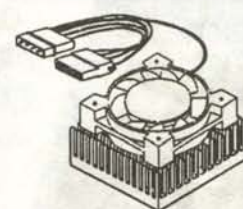
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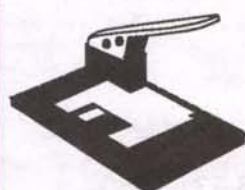
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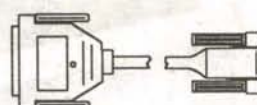
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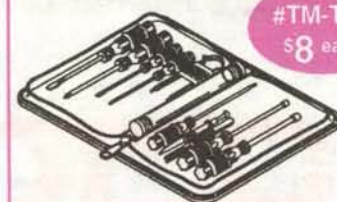
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by Fred Blechman

If you are a radio amateur "ham" or a shortwave listener (SWL), there are many times you might like to locate a ham station you're listening to, or send the ham a QSL (acknowledgment) that you received the signal.

If you are a ham, would you like to find other nearby hams? Also, would you be interested in ham-oriented computer programs that you can use free, or try before you buy?

This article will discuss several CD-ROM discs that will allow you to locate any ham, and also contain hundreds of software programs of interest to hams and SWLs.

I got my first radio amateur "ham" license — K6UGT — back in 1954, just so I could fly radio-controlled airplanes on ham frequencies instead of being limited to 27.255 MHz — the only Citizens Band frequency available at that time. Pretty soon I got involved in building and writing about ham radio equipment, and moved from Technician Class to General Class.

I got on the ham bands and exchanged QSL cards with stations all over the country, and many foreign countries. The "bible" at that time was *The Radio Amateur Callbook Magazine*, which sold for \$5.00, and listed all the ham calls in the USA. It was published quarterly for updates, and was usually just referred to as *The Callbook*. An International Edition was also published.

But times have changed. The

Radio Amateur Callbook (1695 Oak St., Lakewood, NJ 08701; phone: 908-905-2961) 1995 edition will sell for \$35.00

mation package.

CD-ROM Heaven!

If you have a computer with a CD-ROM drive — even an old single-speed CD-ROM drive — you can have (at your fingertips) information about all the hams in the world! Not

Although phone numbers are not given, you can find those with other CD-ROM discs. (See my article, "Using Your Computer to Find Lost Friends," starting on page 90 of the Sept. '94 issue of *Nuts & Volts*.)

As a bonus, these discs contain hundreds of public domain and shareware programs of interest to hams and shortwave listeners — from antenna theory and practice to computerized station logs.

I haven't made an exhaustive survey, but I've found three companies that regularly produce and update CD-ROM discs primarily intended to replace the need for *The Callbook*. The advantages are: more information; instant access; and the bonus programs. These are fine products for present and

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Ham Radio™**

Ham Radio CD-ROMs



AmSoft

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AmSoft, Post Office Box 666, New Cumberland, Pennsylvania 17070. For orders call 717-938-8249 or fax 717-938-6767.

(either USA or international) with a shipping charge in the USA of \$3.00, \$7.00 foreign shipping.

I haven't seen one lately, but my last USA edition (Winter 1962-63) had 568 pages. The 1994 USA edition contains 707,272 names; the International edition has 689,006 names! And now you can get all this information on CD-ROM discs.

If you are not yet a ham operator, but might like to be, write: Gordon West, 2414 College Drive, Costa Mesa, CA 92626, for an infor-

only can you have their full address and zip code, but also the class and renewal or expiration date of their license, and their birth date or year. Some discs even contain station latitude and longitude, area code, time zone, and elevation!

"wannabe" hams, electronic students, and shortwave listeners.

Equipment Required

None of the discs tested were specific about the necessary hardware to run them. Obviously, you need a CD-ROM drive, but it doesn't seem that a double-speed drive is required.

You'll probably need an 80286 or better microprocessor, with DOS 3.2 or better. There doesn't seem to be any special RAM memory, monitor, or printer requirements. Unless you have some really strange or "obsolete" system, you should have no trouble running any of these CD-ROM discs. I didn't.

AmSoft

The World of Ham Radio, CALLSIGN is published three times a year (January, May, September) by AmSoft, P.O. Box 666, New Cumberland, PA 17070-0666; phone: 717-938-8249; FAX: 717-938-6767. Internet: amsoft@e-pix.net. Cost: \$40.00 plus \$3.00 USA or \$5.00 foreign shipping. Annual subscription: \$99.00 USA/\$109.00 foreign.

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- B - FIND BY NAME
- C - FIND BY ZIPCODE
- D - CREATE ZIPCODE MAILING LIST
- X - EXIT THE PROGRAM

CHOICE █

Written for AmSoft by REMware

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E:\>qrz

QRZ! Command Processor Version 2.1 Copyright (c) 1993 by QRZCOM

Database located in E:\callbk
QRZ! [? for help] -> n blechman

Input First Name, or ENTER for all first names:

WA6IHD EUGENE F. BLECHMAN
6373 STONE BRIDGE RD
SANTA ROSA, CA 95409

Class: A 7/5/88
Born: 11/6/22

K6UGT FREDERICK BLECHMAN
7217 BERNADINE AVE
CANOGA PARK, CA 91307

Class: G 6/19/84
Born: 7/23/27

WB3KDH ROBERT M. BLECHMAN
POB 250
HONEY BROOK, PA 19344

Class: T 3/8/88
Born: 12/30/34

3 Records found.
QRZ! [? for help] ->

RESULT OF QRZ! SEARCH FOR BLECHMAN LAST NAME

before what you DO know and CALLSIGN will find all that match the partial search and beyond. For example, /BLE will find ALL names beginning with BLE. Also, the zip code search is ALWAYS on partial, making it real easy to find everyone in a big city. Everything is very fast and highly intuitive in operation.

Buckmaster

HamCall, which runs on both IBM PC compatibles and Macintosh computers, is published twice a year (April and October) by Buckmaster, Route 4, Box 1630, Mineral, VA 23117; phones: 800-282-5628, 703-894-5777; FAX: 703-894-9141. Internet: info@buck.com. Cost: \$50.00 plus \$5.00 shipping. VISA, MasterCard, and Discover cards are accepted. Standing orders and dealer discounts (six or more) are available.

HamCall will search over 670,000 USA callsigns showing station address, zip code, class of license, birth year, expiration date, station latitude and longitude, county, time zone, area code, and elevation. Over 350,000 international listings show the name and address. Over 112,000 old/new cross referenced callsigns are included, as well as over 2,400 club, military, and RACES listings.

HamCall also includes over 500 PC public domain programs and data files. Both IBM PC compatibles and the Apple Macintosh can perform callsign look-up. On the PC you can search by any data element, but with the Mac you can only search by callsign, name, or zip code. Mac users can run PC programs using a

shipping included. VISA or MasterCard are accepted. Clubs can contact AmSoft for special group pricing.

CALLSIGN uses a database of over 750,000 new and previous callsigns, including all USA and possessions, all foreigners licensed to operate in the USA, and trustees of all club and repeater licenses. Searches can be conducted by callsign, last name, or postal zip code, using full or partial inputs.

CALLSIGN will also print out a three-line-label mailing list for any valid zip code. I found 113 hams in my own zip code! This is a great way to find prospects to start or enlarge a local ham club.

The CD-ROM uses an operating menu system called CDVIEW that operates the disc with simple on-screen commands, and on-line help files. The May '94 issue of *The World of Ham Radio* has 14,896 files occupying 504,896,976 bytes on the CD-ROM disc, and most programs can be operated without hard drive space!

Over 7,000 program files cover the latest software releases for amateur radio.

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USING HAM
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Included are over 1,000 radio modification files, and thousands of shortwave frequencies are readable on-line. There is even a file telling you how you can become a licensed ham.

This CD-ROM requires no installation. Just switch to the CD-ROM drive, type CDVIEW, press Enter, and you get a screen showing all the

directories and stand-alone programs. Simple commands are shown at the bottom of the screen.

Select any of the directories and you have access to the programs within that directory. Select CALLSIGN.EXE and you have the CALLSIGN menu. Select your search by callsign, name, or zip code, or create a zip code mailing list. When you make your selection, the appropriate prompts appear.

Type in your search information and you almost instantly see the results — one call at a time — with the callsign, name and address, license class, birthday, and date of license expiration!

If you're not sure of the full callsign or name, just enter a slash (/)

File Search Options
HAMCALL (C) 1994 Buckmaster Publishing
Help=F1
2/754792↑

WORDS	RESULTS
bleazey	blechman 3
blecha	
blecher	
blechinger	
blechl	
blechman	
blechner	
blechschmidt	
bleck	
bleckley	
blechman	

blechman

Enter=OK

3 Matches

Esc=Cancel

1:HAMCALL:

Type search word(s), then press ENTER to search HamCall.

software emulator package called "SoftPC" (call "Mac Warehouse" at 800-255-6227 for current price and information).

This CD-ROM requires no installation and does not use the hard drive except to save label and configuration information. Just switch to the CD-ROM drive, type MENU, press Enter, and — after a sign-on screen with traveling messages — you'll see the HAMCALL™ MAIN MENU with 13 choices. Four of the choices are documentation files for you to read or print out. Don't overlook reading these files, since they contain important information on how to use the search programs and how to print labels.

Select HAM for USA calls, and ICALL/S for callsigns from USA plus 101 countries, with extended information on USA stations.

The HAM program allows incredibly extensive search criteria using a sophisticated search algorithm and three screen sections. The lower section is where you type in your search criteria. The upper-left section shows 10 words near what you've typed, and changes with each character as you type. The upper right section shows how many "hits" have been found for what you've typed so far, and also changes with each character entry.

But the most amazing thing is that HAM looks for these characters ANYWHERE in the database. Therefore, you can type in a street name, a city, even a street number without the street name — any data element or PART of a data element — and it will find it, instantly!

Furthermore, you can use multiple field search criteria, such as FLYNN DON CA to find a Don Flynn in California. You really have to see this in action to appreciate the speed and scope of this search technique.

You can print a list of labels with this program, but it's kind of awkward, and you need to go through

several steps to first save the information you want on disk, then use a program called PRINTLAB to do the actual printing of one-across three-line labels.

For more detailed information and direct label printing, ICALL/S is provided, but it searches ONLY by callsign. You can use HAM to find the callsign, then use ICALL/S to get further information for USA calls, like latitude and longitude, elevation, time zone, and telephone area code — and to directly print labels.

A program called LOOKUP is a TSR (terminate and stay resident) program that allows access to all callsigns from any DOS text mode application by just pressing Ctrl-Alt-C. For example, this lets you get callsign data while using a logging program or a word processor.

It will take some time for you to get familiar with some of the features and capabilities of HamCall, but once you do, you'll realize you have a tiger by the tail!

Buckmaster also produces *The Electronics Software Compendium* CD-ROM disc (\$25.00 plus \$5.00 shipping), which is a collection of programs and data files that pertain to electronics, broadcasting, amateur radio, and SWL activity. It has over 15,000 files in total, with automatic unzipping to your hard drive. The files include circuit design and analysis, basic information on electronic formulas, reference charts, and much more. It is updated every April and October. The April '94 issue has 200 megabytes of IBM PC programs, and over 20 megabytes of Apple Macintosh programs.

Walnut Creek CDROM

QRZ! Ham Radio CDROM, which runs on IBM PC compatibles in both DOS and Windows, is published semi-annually around May and November by Walnut Creek CDROM, 4041 Pike Lane, Suite D,

Concord, CA 94520; phones: 800-786-9907, 510-674-0783; FAX: 510-674-0821. Internet: orders@cdrom.com. Cost: \$29.95 plus \$5.00 shipping USA/Canada or \$10.00 Air Overseas. VISA, MasterCard, Discover, and American Express cards are accepted. Yearly subscriptions are available for \$19.95 per issue. A UNIX version is also available.

QRZ! Ham Radio CDROM contains a list of over 750,000 hams from the USA, Canada, Great Britain, and Italy. The search and retrieval program will locate and display any included callsign in under two seconds, directly from the CD-ROM disc; the hard drive is not required.

In addition to callsign, name, and address, the retrieved data includes class of license, last previous callsign (if any), birthdate, and date of license or last renewal. You can search by callsign, name, city/state, or zip code and send the results in various formats to your screen, printer, or a disk file. This makes it very easy to directly print records in a list or as mailing labels.

In addition to the callsign database, the disc contains: all the Usenet news ham radio archives since 1989; the FCC Rules Part 97; 150 radio and scanner modifications; DX lists, DXCC info, BBS lists; and hundreds of indexed shareware ham radio programs, including a copious variety of Sound Blaster compatible .WAV file recordings of popular digital data transmissions such as RTTY, Packet, and AMTOR.

To run under DOS, you just switch to your CD-ROM drive, type GO at the DOS prompt, press Enter, and the README.TXT file is displayed. No installation or set-up is necessary. To run the callsign database from the DOS prompt, simply type QRZ and press Enter. When you get the screen input prompt, type ? and Enter and you'll see a

help file (QRZHELP.TXT) with all the subcommands. Very fast and easy.

If you're a Windows fan you'll need Windows 3.1 or better. The callsign database program is QRZWIN.EXE. Don't forget to look in the WIN3 directory for a number of useful Windows help files. QRZWIN requires no installation; just pop in the disc and run it from Windows. You may want to create a program item in one of your favorite groups which points to QRZWIN.EXE, and includes its own icon.

QRZ! is the least expensive of the ham radio CD-ROMs I tested, and is quite adequate for most users. It is particularly easy to use once you read through the DOS README.TXT and QRZHELP.TXT files, or the Windows QRZ.HLP file.

If you're a programmer, QRZ! offers you two special advantages. All the inner workings of the on-disc database are completely documented so that programmers can write their own programs using the QRZ! database. All this information is stored in plain text without encryption.

Also, quality contributions from amateur radio shareware authors are welcomed. Walnut Creek CDROM is interested in any data or information files which would be of interest to the general amateur radio community. To submit your data and/or software for inclusion in a future version of QRZ!, just send E-Mail to cdrom@qrz.com or write to: QRZ! c/o Fred Lloyd, 8215 E. Wood Drive, Scottsdale, AZ 85260.

Walnut Creek CDROM produces over 30 other CD-ROM discs that might interest you. Call them for a free catalog. NV

Fred Blechman has written over 650 magazine articles and five books about electronics and microcomputers since 1961.

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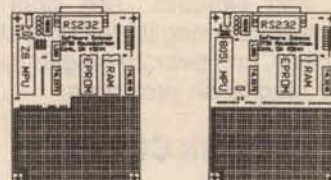
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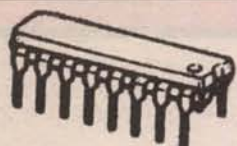
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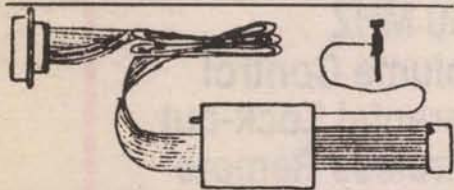
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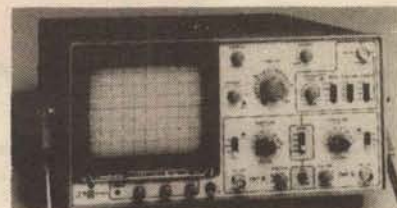
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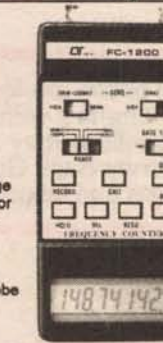
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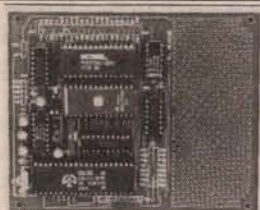
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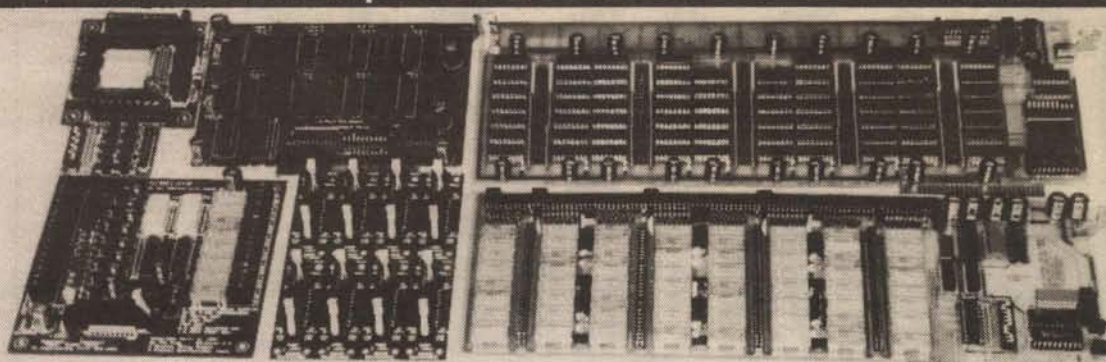


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- Machine pin sockets make field repairs a snap.
- Silk screened, solder masked, & gold plated.
- See SCREWTERM, TERMACK, SCRELAY8

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16 Channel Screw Terminal Board

- Directly interfaces to any port on SCPIO16.
- Supports 8 Input + 8 Output channels.
- LED Bargraph Displays monitor inputs & outputs.
- Screw terminals for all I/O, control & power lines.
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- Fuse protected power lines.
- Screw terminal blocks socketed for quick release.
- Minimize your setup time.
- Reduce maintenance and repair costs.
- Saves many hours of building & wire wrapping.
- Shrouded Gold plated header with ejectors.
- Boards are Solder Masked & Silk Screened.
- I/O, Pwr, Gnd, Cntrl identified with legends.
- 3"x3" board with mounting holes & hardware.

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128 Channel Termination Board

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- Supports full set of 8 SCPIO16 cables.
- Supports 128 channels. 64 Input / 64 Output.
- 2 solder pads for ea. signal, control, & power line
- Provides simple interface to Solid State Relays.
- Easy interface to many other devices.
- Simple interface to wide range of sensors.
- Saves many hours of building & wire wrapping.
- Shrouded Gold plated headers with ejectors.
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64 Channel Relay Board

- 64 SPST 10VA 100 VDC 70 VAC 0.5 AMP relays.
- Use to drive solenoids, valves, relays, contactors.
- 16 Relays per 64 line gold plated header.
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- Set port 1 to monitor selected channel.
- Read port 0 to determine response.
- Then scan 1 to 240 channels for response.
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- Every output paired with an input channel
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- Full size fuse protected PC/AT form factor card.
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Nuts & Volts Magazine/November 1994 29

OPEN CHANNEL

by
Harry Helms

And The Latest Rage Is . . . Vacuum Tube Radio!

You may have noticed something unusual in the various ads here in *Nuts & Volts* or at the ham-fests listed here each month. The prices of old vacuum tube radio receivers and transmitters have been steadily climbing over the past couple of years. In fact, a lot of vintage ham gear from the 1950s and 1960s fetches more now than it did when it was new!

I'm one of those afflicted with this strange mania for collecting vacuum tube ham gear, and my radio room contains several working models of vintage tube equipment made by such legendary companies as Hammarlund, Hallicrafters, Drake, and Heath.

While today's solid-state radio equipment is generally superior to vacuum tube gear, the old stuff does have some significant advantages in certain applications, such as the transmission and reception of AM signals.

Vacuum tube gear is remarkably forgiving of your attempts to modify or repair. There are no static-sensitive CMOS devices or fragile discrete devices that can be destroyed by too much heat from a soldering iron. The chassis of most vacuum tube equipment is remarkably spacious, with plenty of room between components.

Trying to work on today's solid-state gear gives me a headache, while working on my vacuum tube stuff is relaxing! And even at today's higher prices, it's still possible to find some real bargains in vacuum tube gear.

WHAT'S SO GREAT ABOUT TUBE GEAR?

Older vacuum tube gear is not well suited for many more contemporary purposes, such as single sideband (SSB) communications. The dial calibration and stability of tube gear is markedly inferior to more recent gear, and tube equipment is bulkier, gives off more heat, and fails more often. Features like frequency synthesis and tuning memories were just pipe dreams back in the 1950s and 1960s. So why bother with tube gear?

One big reason is if you're interested in the transmission and reception of AM signals of any frequency. The 1950s and early 1960s were the golden age of AM on the ham bands, and transmitters and receivers were optimized for performance

in that mode. By contrast, SSB rules ham voice communications these days and the AM capability of most of today's ham gear is little more than an afterthought. As a result, many vacuum tube receivers from three or four decades ago can outperform most of today's solid-state receivers in the AM mode.

For example, one of my favorite receivers is my Hammarlund HQ150, which was introduced in 1955. Despite its age, it actually receives most AM signals (on the AM broadcast band as well as shortwave) better than some modern receivers costing over \$1,000.00! Its noise limiting circuit does a better job of reducing electrical noise in the AM mode than any solid-state receiver I've ever tuned.

The same thing applies for transmitting gear. Many tube transmitters employ plate ("high level") modulation to produce AM, whereas most contemporary solid-state gear applies the modulation to the base of the power transistor. This so-called "low level" modulation gives a lower level of average modulation and reduced audio quality. If you want to put a high-quality AM signal on the air, an older vacuum transmitter is the best way to go.

There are many people who swear that the audio from vacuum tube receivers is superior to the audio from solid-state receivers. This is not a contention unique to radio hobbyists. There are a substantial number of audiophiles who swear that the sound from tube audio amplifiers is superior to that from solid-state amplifiers; there are currently over 50 different companies worldwide manufacturing expensive new vacuum tube audio gear!

Some leading musicians, like guitarist Eric Clapton, only use tube amplifiers when they perform. When you ask such "golden ears" why tube

audio gear is superior, they will describe the sound as "fuller" and "mellower," often adding that the various audio frequencies blend together better in a tube amplifier. I don't know if all that's true, but I do agree that most tube receivers sound better than most solid-state receivers.

One big reason is that the audio stages of many newer receivers have been designed with amazing sloppiness. The distortion in the audio output of some modern receivers (including those retailing for over \$1,000.00) exceeds 30%; other receivers use a general purpose op amp for their audio output instead of a special audio op amp. Other solid-state receivers are designed for maximum audio performance in the SSB mode and give scant attention to AM reception.

Tube receivers tend to have greater resistance to overloading and better ultimate selectivity than solid-state receivers. One reason is that vacuum tubes inherently have better strong-signal handling capability than most transistors.

Another is the shielding and spacing between components in tube receivers and the good grounds offered by the metal chassis of tube receivers.

In most solid-state receivers, components are in close physical proximity to each other and not electrically isolated from each other to a great degree. This means undesired signals can be coupled between circuit stages or "leak."

Finally, older tube gear has some neat features for AM use that just aren't found on more recent solid-state equipment. I've already mentioned how noise limiting is usually superior in AM on older receivers. Most older tube gear can work with a much wider range of antenna impedances than the 50 impedance required by most solid-state gear. Older receivers include interference-fighting circuits especially suitable for AM mode reception, such as Q-multipliers and phased crystal filters, that are not available on any modern receiver. And maybe the best feature of all is a certain "class" that older tube equipment has, much like a Corvette or Thunderbird from the 1950s and 1960s!

WHAT ARE THE PROBLEMS?

Classic tube radio gear isn't for you if you're the type who wants just to "plug and play" equipment. Almost any receiver or transmitter from the 1950s and 1960s will require some work before it will function acceptably.

The biggest problem with vacuum tube equipment isn't the tubes. Most tubes used in the 1950s and 1960s are still available in a reasonably good supply, although there are a few oddball tubes that are difficult to locate.

Instead, capacitors provide the biggest headaches. Most of the wax-coated paper and electrolytic capacitors used in such radios will need to be replaced, as the electrolytic material in such capacitors will have dried out.

Fortunately, mica or ceramic capacitors of the same capacitance and working voltage can be substituted for the wax-coated paper capacitors and new electrolytics can directly replace the original ones.

The first thing many fans of classic radio gear do with a new acquisition is replace all the remaining original electrolytic and wax-coated paper capacitors!

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An ad from 1958 for the Hammarlund HQ160 receiver, one of the prizes in your columnist's collection of classic tube radio equipment. To keep that \$370 price tag in proper perspective, remember that in 1958 gold was \$35 an ounce, gasoline was 20¢ a gallon, and the average yearly income was under \$5000.

A serious, long-term problem is the lack of such replacement parts as power transformers, coils, dial plates, and knobs, etc. Often parts must be "scrounged" out of a non-working model of the same unit. This is why non-working units of popular transmitters and receivers have also been rising in price recently; where else can you get a replacement tuning mechanism for a Hammarlund HQ180 receiver?

You will need to do maintenance on a regular basis, especially on tube receivers. This means you will need (or have access to) such test equipment as an RF signal generator, a frequency counter, and sometimes an odd item like a dip meter.

THE BIG NAMES

Most of the big names in radio equipment from the 1950s and 1960s are no longer around. In some cases, the company itself (Hammarlund, Hallicrafters, etc.) is completely out of business while other companies (Collins, Johnson, etc.) no longer manufacture any sort of ham radio gear.

The only company to successfully make the transition from vacuum tubes to solid-state was the R. L. Drake Co. Famous today for their R8 shortwave receiver, Drake first made its name with classic tube receivers like the 2B and R4B models. One major advantage of Drake receivers is that the company still has manuals and many spare parts available and offers some repair service for their older rigs.

The Rolls-Royce of tube gear was Collins. Even today their 51J4 and R390A receivers are recognized as among the finest AM mode receivers ever built and are highly prized by hams and shortwave listeners.

Collins made its big name in SSB, with transceivers like the KWM2, still used today by the U.S. military. Unfortunately, Collins did very little in the way of AM transmitting equipment.

Collins gear is still relatively available and its reliability is legendary; there are also numerous parts sources and repair specialists for Collins items. All this comes at a price, however. Expect to pay top dollar for good Collins gear. For example, a 51J4 or R390A in good condition can easily fetch several hundreds of dollars.

There are probably more items of Hallicrafters equipment available than from any other manufacturer. More shortwave listeners and hams started out with Hallicrafters in the 1950s and 1960s than

any other gear. (I was one of them; my first shortwave radio was the Hallicrafters S-119.)

Hallicrafters used simple circuitry and readily available components to make their rigs more affordable than the competition. Unfortunately, this meant that the performance and reliability of most Hallicrafters models just wasn't that good. However, some Hallicrafters items were outstanding performers for the money.

The SX-100 shortwave receiver was the first reasonable priced unit to offer satisfactory SSB reception and is still an excellent receiver by today's standards.

The HT-32B transmitter put out a high quality AM signal on the 80 to 10 meter ham bands at over 100 watts.

Heath was another company that manufactured numerous different models of gear at a reasonable price. Their gear came in kit form, and so the performance and quality of an item of Heath equipment heavily depends on the skill of the person who built the kit.

The DX-60 AM transmitter may be the most popular transmitter used by pirate radio operators!

Another popular Heath AM transmitter was their DX-100, a high-power unit with good modulation.

My all-time favorite shortwave receivers were manufactured by Hammarlund. My current collection includes the HQ100, HQ150, HQ160, HQ180, and HQ200 models. Hammarlund receivers are known for their excellent selectivity, effective noise limiters in the AM mode, and superb strong-signal handling capability.

Hammarlund receivers are especially popular with those who chase distant stations on the standard AM broadcast band. The HQ180 model, manufactured from 1959 to 1971, is considered one of the finest receivers ever made. I use one in conjunction with an RF signal generator and frequency counter so I can accurately determine frequencies, and find the 35-year old Hammarlund performs better than most new receivers costing over \$1,000.00.

Another superb Hammarlund receiver for the AM broadcast band is the HQ150. It is highly sensitive at lower frequencies and has terrific adjacent channel selectivity.

For those interested in transmitting AM signals, it's hard to top the transmitters made by the E. F. Johnson Company. Johnson's Valiant and Ranger II AM transmitters are still used by everyone from

hams to pirate radio operators to smaller broadcasters in the Third World!

Johnson transmitters have AM power levels of a couple of hundred watts and some of the most beautiful audio you will ever hear via amplitude modulation; they sound about as good as it's possible for AM to sound.

Johnson was also known for their "Messenger" series of CB transceivers. These can be easily modified for operation on the 10-meter ham band. Of course, they were originally popular among CBers in the 1960s because their power could be boosted to over 20 watts (compared to the legal five-watt limit) merely by removing a "ballast" resistor on the final amplifying tube socket!

FINDING VINTAGE GEAR

It takes effort to locate good examples of classic tube radio equipment. One good place to look is at the electronics shows and hamfests listed in each issue of *Nuts & Volts*. Another good place is in the classified ads listed here, as well as specialized ham radio publications. However, good stuff can turn up in really unexpected places.

For example, I managed to buy a Hammarlund HQ180 at an estate auction mainly devoted to non-radio items. I paid \$50.00, while the same receiver would have probably gone for four or five times more at a hamfest or electronics show.


One of the best ways to get familiar with classic radio equipment is to check out the ads and equipment reviews in back issues of ham radio magazines like *QST* (check your public library for such issues).

Another good source of information is *Communications Receivers: The Vacuum Tube Era* by Ray Moore. This heavily-illustrated book describes virtually all American-made vacuum tube receivers made and is available from many of the book dealers who advertise in *Nuts & Volts*. Finally, a monthly publication devoted to collecting, restoring, and using vacuum tube radio gear is *Electric Radio*. A subscription is \$38.00 per year from P. O. Box 57, Hesperus, CO 81326.

The fun of restoring and using classic vacuum tube radio gear cannot be easily described. It's something you have to experience for yourself. Even if you got interested in radio communications in the post-vacuum tube era, don't be surprised if you find yourself falling under the spell of vacuum tube gear! **NV**

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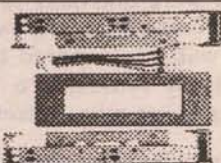
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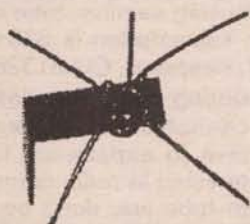
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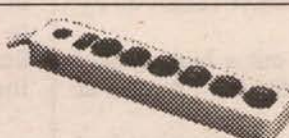
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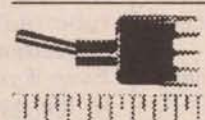


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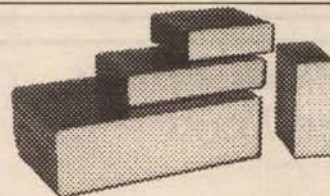
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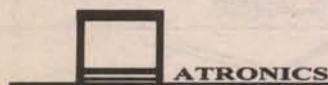
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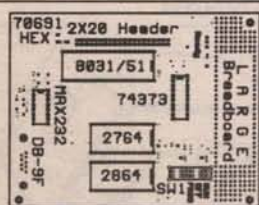
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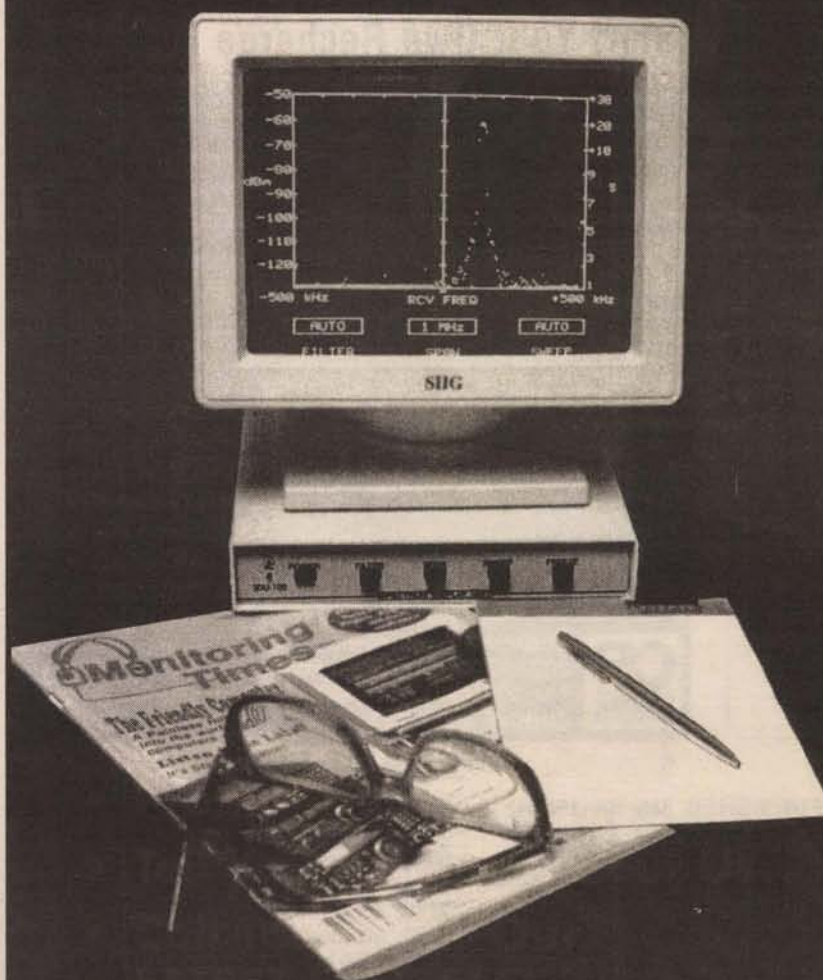
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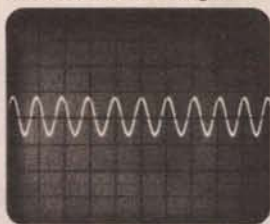
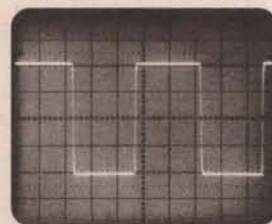
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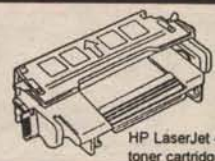
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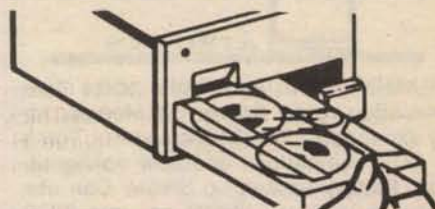
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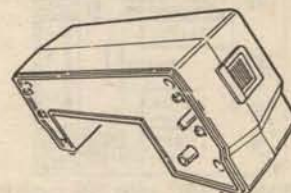
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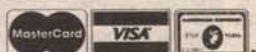
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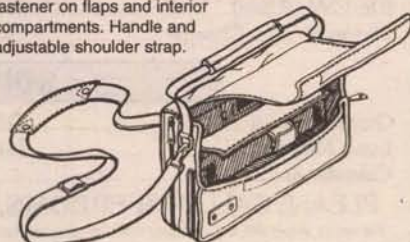
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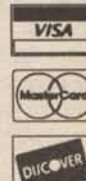
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THE LASER

EXPERIMENTER

Conducted by
Anthony Charlton

Welcome! This column marks the first in a series where we'll design our own power supply for a Helium-Neon laser. While diode lasers are becoming more and more popular, they can't be used in holography because they possess insufficient COHERENCE LENGTH. Therefore, there probably always be a need for He-Ne lasers — even if diodes become inexpensive — unless the coherence length problem is resolved.

The design of a laser power supply must take into consideration several factors — indeed like the design of any other engineering project no matter how simple or complex it may be. Since we'll be doing this project step-by-step, we shall first begin by examining the elements of power supply design, and define the properties we want in our laser power supply, and work in concert with those properties as the project progresses.

Design Begins with Batteries and Portability

First of all, it is more logical to have portability with a power supply/laser combination. This enables you to transport the system into the field, which is where a lot of experiments from this column are performed. This entails the need for a reliable source of portable energy, for which we shall use a 12-volt, lead-acid rechargeable battery commonly called a "gel-cell."

Gel-cells have the advantage over liquid lead-acid batteries in the sense that they can be operated in any physical position, which a liquid battery cannot. And they pack approximately the same power density per cubic inch as a liquid cell — so, all things considered, they are an excellent choice.

If you have a permanent installation where the battery will not be subject to position changes, then it would be fine to use a liquid lead-acid battery. In such a case, it is necessary to maintain the battery properly in accordance with the manufacturer's directions.

Keep it charged, wipe off any accumulation of metal/acid compound "fuzz" that will accumulate on the terminals, and keep the top of the battery clean of electrolyte by periodically wiping it off with a saturated solution of water and baking soda, followed by a pure water rinse.

Another tip that I have found to be extra helpful is once in a while, tip the battery back and forth whenever

you charge it to distribute the electrolyte density evenly within each cell.

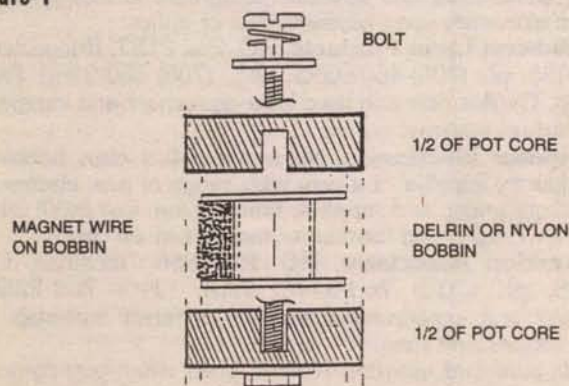
Also, place a rubber or wood mat between batteries and cold cement floors, because it seems that there is some effect where the cold penetrates the bottom of the battery and causes premature failure. Presumably this failure mode is caused by a density build-up of the electrolyte on the bottom of the battery cell plates, and consequent increase of conductive lead-acid compounds that result in shorting between the plates of each cell, and ergo, the cells become reduced in capacity and eventually fail.

Nickel-Cadmium batteries are okay for laser power supplies, since they share many of the same characteristics as lead-acid cells. The characteristics for both types include:

- * Rechargeability.
- * High peak amperage draw capability.
- * Low cost on a time-averaged basis vs. throw-away batteries.
- * Output voltage and current remain relatively constant until the cells are exhausted, at which point, the batteries exhibit a sharp drop-off in voltage. This is quite unlike non-rechargeable batteries, which exhibit a gradual decline in power, and that is undesirable for use with the laser power supply.

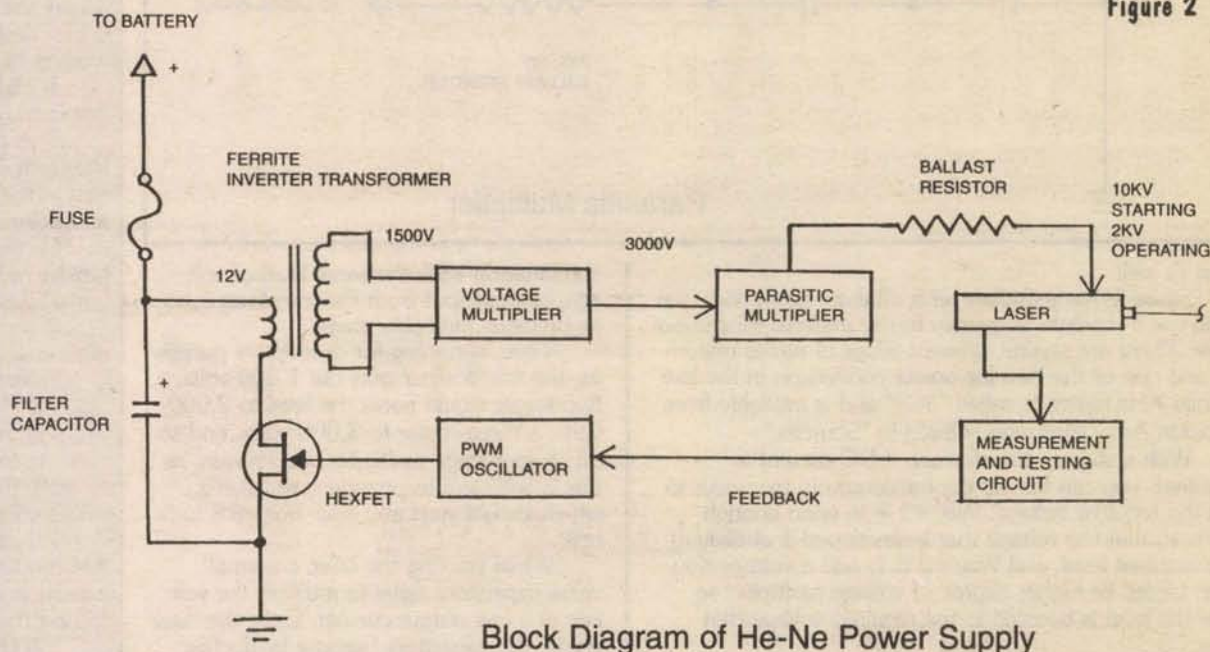
Once you are satisfied you have a reliable battery, it's time to move on to the next step. Battery chargers are available from the vendors of gel-cells, and are designed for that kind of cell. Avoid mis-matching the charger to the battery, or you will reduce its life.

Figure 1

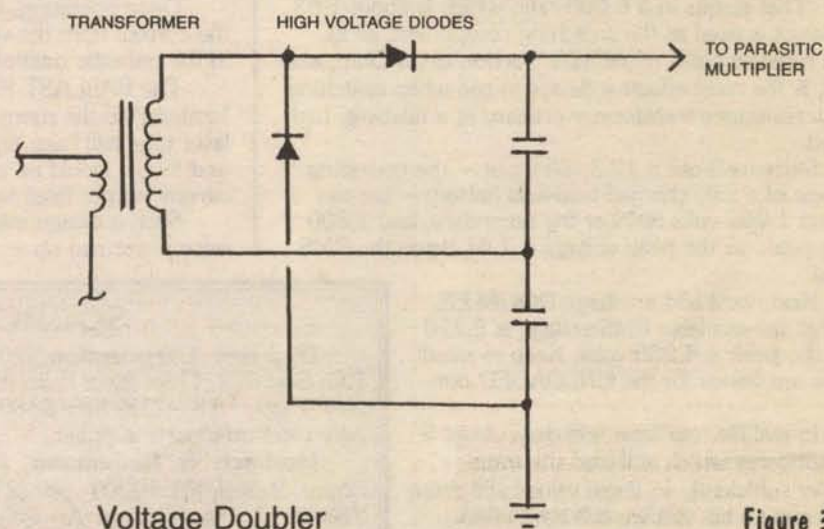


Pot Core Transformer

Figure 2



Block Diagram of He-Ne Power Supply



Voltage Doubler

Figure 3

Designing a Step-Up Transformer

With the prototype, whose schematic appeared last month, a TV flyback core was rewound with 2,000 turns of wire on the secondary. Since this is rather tedious, it was decided to replace the flyback core with a ferrite core called a POT CORE. It's called that since it looks like two pots fastened together with a bolt through the center. Figure 1 depicts the design.

Trying to fit 2,000 turns on such a core is unreasonable, so a much more easily attained 500 turns is called for. Don't get scared off, because you won't wind each turn by hand. An electric drill with a variable speed control is used to quickly apply the proper number of turns.

We used a modified wood lathe for all winding projects, equipped with a foot pedal that controls the speed.

With such an arrangement, a complete transformer can be wound in five minutes — a minuscule investment of time. Plus we'll give details of the technique as the project unfolds in the months ahead. You can apply the same knowledge to transformers for other electronic

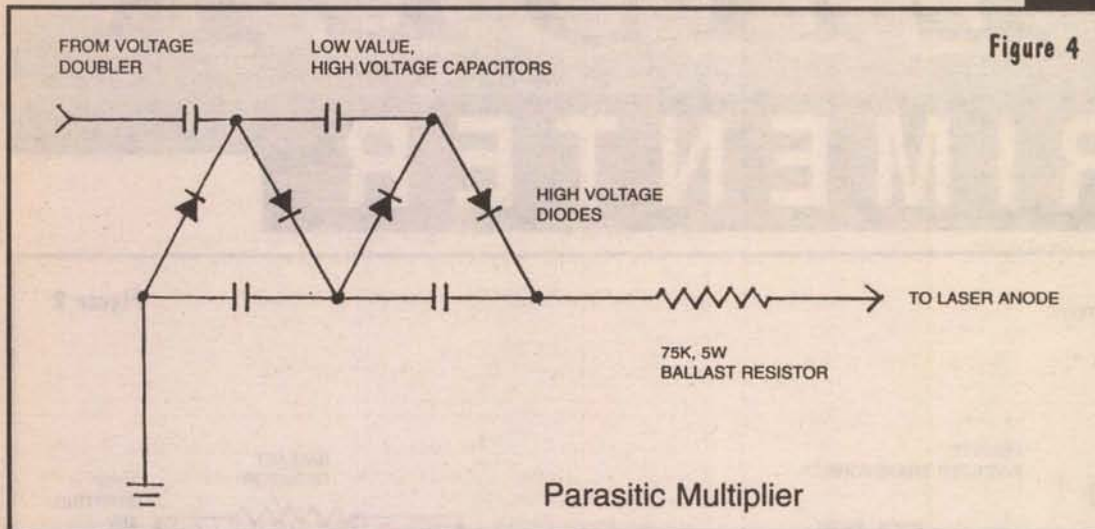


Figure 4

uses as well.

Since ferrite materials have different properties, we shall use a medium frequency ferrite material for the pot core. There are several different alloys of ferrite material, and one of the best for power conversion in the low to mid KHz region is called "3C8" and is available from Amidon Associates who is listed in "Sources."

With a step-up transformer, if DC current is required, you can handle the turns ratio in two ways to get the required voltage. Way #1 is to wind enough turns so that the voltage that is developed is already at the required level, and Way #2 is to add a voltage doubler, tripler, or higher degree of voltage multiplier so that the level is boosted to the required voltage that way.

An approach that combines both ways was used. First, the primary consists of six turns of #18 copper wire. That results in a 6:500 ratio which is about 1:83. A Hexfet is used as the switching component, as its own resistance is a remarkable fraction of an Ohm, and thus, is the most effective device to use when switching a low resistance transformer primary at a relatively high speed.

Since we'll use a 12.8 volt input — the operating voltage of a fully charged lead-acid battery — we can expect 1,065 volts RMS at the secondary, and 1,500 volts peak, as the peak voltage is 1.41 times the RMS value.

Next, we'll add a voltage DOUBLER, so that the available RMS voltage is 3,210 and the peak is 4,230 volts. Keep in mind these are values for the UNLOADED output.

In real life, our laser will draw about 5 milliamperes which will load the transformer sufficiently so these values will drop back quite a bit. But we still have enough "oomph" to run a 5 milliwatt tube, which is our intention.

Figure 2 shows a block diagram of the laser power supply and its sub-assemblies. Figure 3 shows the voltage doubler. This uses high voltage diodes and high voltage ceramic disc capacitors. The values will be determined later on as the project progresses and is refined. This goes for most of the part values in this first installment about building a power supply.

Since a laser requires a high voltage start pulse of up to 10 KV for the size we'll be working with, we have to find a way to achieve this voltage boost. A PARASITIC MULTIPLIER was chosen, as only a few microamperes are needed to ionize the gas inside the laser, and start it fully conducting. Figure 4 shows the design.

The parasitic multiplier attaches to the output of the voltage doubler. This type of multiplier is called the Cockcroft-Walton or the "ladder multiplier." Note how simple it is!

Each stage of the diode/capacitor

combination adds the same level of voltage, as produced from the transformer, to its previous multiplier stage.

Thus, assuming for descriptive purposes, the transformer puts out 1,000 volts, a two-stager would boost the level to 2,000 volts, a three-stager to 3,000 volts, and so on. A four-stage multiplier was chosen, as this is sufficient to provide over 10 KV, which should start any laser from 0.5 to 5 mW.

While starting the laser, the small value capacitors serve to multiply the voltage at a low output current. Once the laser starts, the capacitors become ineffective since the operating current is hundreds of times greater than the starting current.

Once operating, the forward-biased diodes conduct the current from the voltage doubler, and the capacitors in the parasitic multiplier no longer affect the circuit.

The BALLAST RESISTOR serves to maintain a "cushion" to the running laser tube. This is since each laser tube will have slightly different operating specs, and thus it would be impractical to have the voltage and current output fixed to the laser tube.

Such a design might easily burn out the laser tube once it warmed up — not the most practical way to

LASER POWER SUPPLY SPECIFICATIONS

- 1) Adjustability. Should power 0.5 mW to 5.0 mW tubes.
- 2) Series resistor in CATHODE to measure current using the 20 volt range of a DVM or DMM. 1% resistor essential for accuracy. Voltage drop across it corresponds directly to volts equals milliamps, through the tube, at this DVM range.
- 3) Voltage divider resistor network on laser ANODE to measure tube voltage. Uses 20 volt range of meter. One volt equals 100 volts across the tube. A ZNR, SIDAC, DIAC, or other protective semiconductor device prevents damage to the meter in case the resistor network quits.
- 4) High power ballast resistor works with any size tube to regulate current and voltage to it.
- 5) A current feedback limits the drive current of the primary transformer via a PWM drive circuit. This is to prevent runaway current in the tube when it heats up. Also, will prevent mode-hopping and polarization drift in tubes used for holography.
- 6) Nice big PC board with plenty of clearance, so the first time builder has no problem putting the project together.
- 7) Fused primary input.
- 8) Indicator lamps show the presence of primary power and high voltage.
- 9) Test points on the circuit board for:
 - a) PWM oscillator.
 - b) Transformer's AC output to multiplier circuits.
 - c) Collector of switching Hexfet.
- 10) Five-second "CDRH delay" with an LED shows when the primary oscillator is energized after the built-in power-on delay.
- 11) Jacks that can be cut to install a modulation transformer for AM modulation of the beam. A bypass resistor prevents open-circuit condition of the supply just in case the transformer fails, thus protecting the power supply.
- 12) Use of parts that are not difficult to locate. A vendor list will be supplied for all components.

operate an expensive piece of equipment, eh?

So, the large value ballast resistor automatically adjusts the voltage to the tube. It is usually rated at 75,000 ohms and 5 watts, and this is the value we'll use.

In order for the circuit to operate stably over the various temperature changes (circuit, ambient, and the laser tube), it is a good idea to have a feedback mechanism to regulate the power to the step-up transformer.

Such a circuit also increases efficiency and reduces

SOURCES

Digi-Key Corporation, 701 Brooks Avenue South, P.O. Box 677, Thief River Falls, MN 56701-0677; ph: (800) 344-4539, FAX: (218) 681-3380. Free catalog. Top quality new electronic parts supplier.

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Edmund Scientific Company, 101 East Gloucester Pike, Barrington, NJ 00807-1380; ph: (609) 573-6250, FAX: (609) 573-6295. Free catalog. Supplier of a wide variety of educational and scientific equipment including lasers and an extremely comprehensive line of optics.

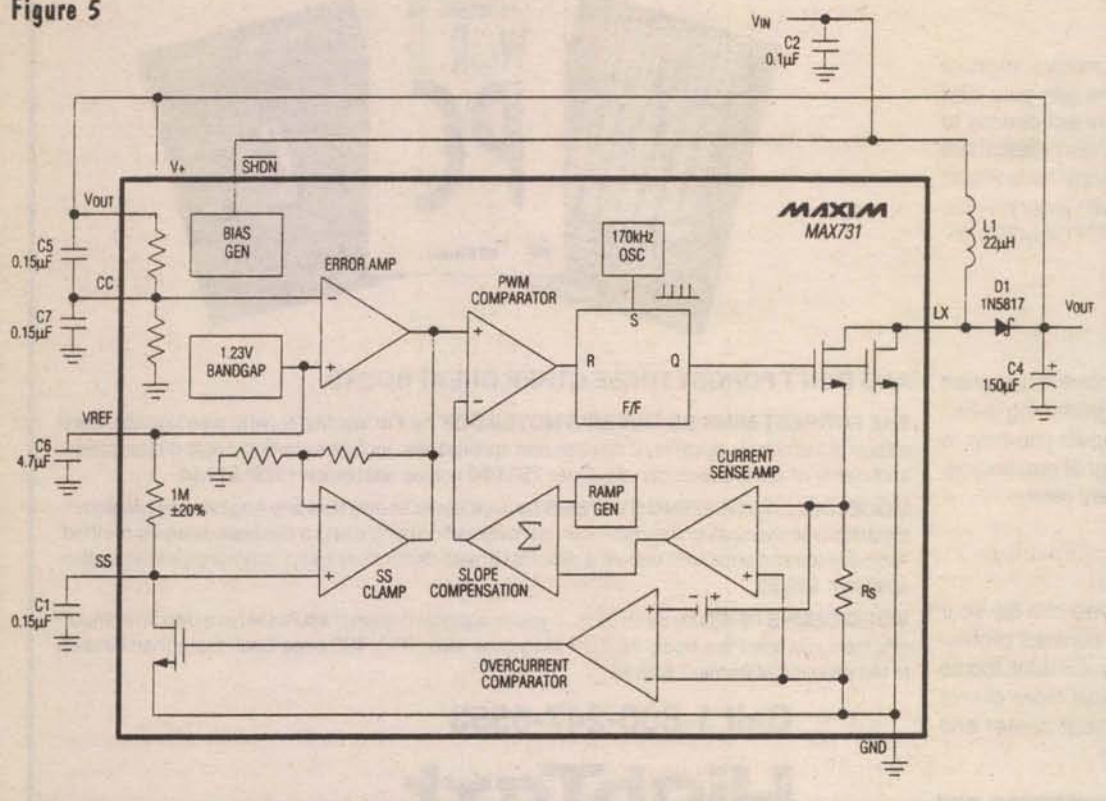
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Figure 5



battery drain. This circuit will take the form of a Pulse-Width-Modulated (PWM) driving waveform.

It works like this: As the wave is narrowed and widened, the power level tracks accordingly.

We'll use a dedicated integrated circuit in the design to regulate the power. I'll try several and choose the best one for the project later on. But you may find it interesting that such chips are available, and that all the electronics are inside one IC package, such as the PWM inverting power supply chip manufactured by Maxim. Figure 5 shows what the interior circuitry looks like. We may not wind up using this particular chip, but it's fun to see what it contains, nevertheless.

On a sidenote, while researching this project, I took half a day to skim through some databooks by IC manufacturers, and it's absolutely incredible what is now available. Everything from fluid level sensing chips to dedicated microcontrollers to ultrasonic ranging ICs.

Many of these products are available through Digi-Key and Mouser Electronics, listed in "Sources."

It's a good idea to purchase databooks published by Texas Instruments, National Semiconductor, Maxim, Harris, and Linear Technology — as budget permits — to keep abreast of the fascinating developments in this area.

To allow feedback from the circuitry of the laser to the PWM circuit, a voltage divider is used on the laser to give a reference to work with. There are also several features uncommon to conventional laser power supplies that enhance the versatility of our design-in-progress. Those features are detailed in the box.

Schematic to Appear in Stages

One of the fun aspects of dealing with a new design is developing it in sections, and then piecing them together as an integrated unit. This we shall do together over the next few months, so that you can really get the sense of how it is to build a somewhat complex project from the ground up.

As before, (in most cases) we shall include a CAD-generated PC board pattern which will have lots of room, so that the project can be built by the beginner to electronics, provided the directions are followed closely.

I look forward to developing this project along with you, and welcome any suggestions that you may have. Send all letters to The Laser Experimenter's P.O. Box listed elsewhere in this article.

As a matter of fact, we are running low on letters lately, so if you have the chance on some chilly day when you are shut inside, we'd love to hear your suggestions, even if it's just a short postcard!

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Anthony Charlton is an active electronics and science "do-it-yourself" project designer, does custom R & D and writes technical articles. Previous work experiences include design of hardware & software for microprocessor-based process control systems and electronic design. His hobbies include lasers, gardening, target shooting, and model rocketry.

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Complex Theoretical Optical Theory

Hmm ... when one delves into the theory of Complicated Anything, it sometimes becomes a little too hard to digest on schedule — ergo, we have to postpone explaining the theoretical concepts that were planned for this month. I plan to begin to run them next month. The prime focus is the fascinating developments to do with non-linear optics.

That is the science whereby a laser beam can be passed through a crystal of an exceptionally pure and specific substance, and the beam can be changed in wavelength (color) to a predetermined specification because of the atomic and physical dimensions of that substance.

It is believed among industry experts that this aspect of laser technology holds great promise for the future.

Already the manufacturers are proliferating and the applications expanding in the area of controlling laser frequency with crystal substances. The progress and diversity is tremendous.

So, we'll drop in from time-to-time and keep an eye on this progress, which is sure to affect amateur laser experimentation in the future.

That's it until next month, when we look at this non-linear technology and continue to refine the design of our laser power supply. NV

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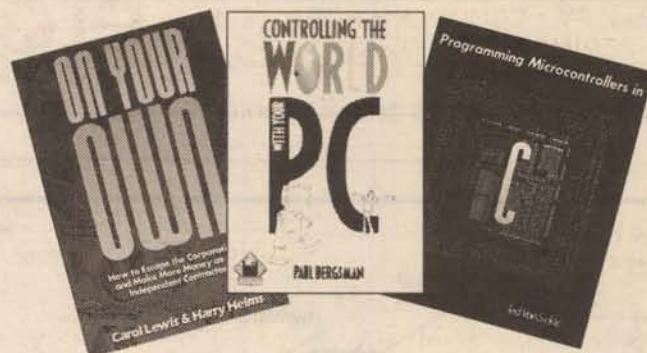
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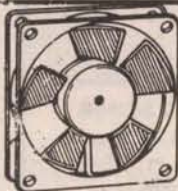
MODEL #4715ML-012P540-00
12 VDC 0.5AMPS - 120 CFM
Control Temp 40°C - Brushless
D.C. FAN. 5 Blade Plastic Impeller
Aluminum Housed. Size: 4 11/16" SQ. x
1 1/2" thick. 8" Wire leads. Fan complete
with Thermostat control Sensor
BRAND NEW FACTORY PACKED.
BRIGAR SPECIAL PRICE ... \$12.95



NEW

12 VDC FANS

CANON #CF120-T302N3D
4 11/16" SQ. X 1 1/2" THICK
5 BLADE - 8" WIRE LEADS
PLASTIC HOUSED - PLASTIC
IMPELLER. 12VDC 410ma. 100
CFM AIR FLOW. LOW NOISE.
WEIGHT 1/2 LB. **BRAND NEW**
SALE PRICE \$7.95 ea.



NEW

NIDEC TORIN #TA450DC

MODEL #A31256-16
12VDC .42 AMP 3 BLADE.
METAL HOUSED-PLASTIC IMPELLER
4 11/16" SQ. X 1 1/2" THICK. 12" WIRE
LEADS. WEIGHT 1 LB. 100 CFM
BRAND NEW FACTORY BOXED.
SPECIAL SALE PRICE \$7.95



NIDEC-TORIN TA600S

HIGH VOLUME FANS 115VAC
MODEL #A32060-10 115VAC .250/.20A
50/60HZ IMPEDANCE PROTECTED.
135CFM 3200RPM SIZE: 6.25" DIAM
1 1/2" THICK- **BRAND NEW FACT-**
ORY BOXED. PRICE \$14.95
5 FOR \$60.00



NEW

3 SECTION CHASSIS SLIDE

GRANT #SS300NT 24"

IWS-CPU RACK MOUNT SLIDES
3 SECTION. MATERIAL: HARD COLD
ROLLED STEEL. LOAD CAPACITY 200 LBS
ON A PAIR. BUILT IN PERMANENT DRY LUB-
RICANT, NEVER NEEDS OILING. SUPERIOR
PERFORMANCE AGAINST HIGH SHOCK &
VIBRATION. MOUNTING HARDWARE INCLUDED
SIZE: 3 1/8" HIGH X 3/8" THICK
24" CONTRACTED LENGTH
48" Extended over all length
(24" BEYOND CABINET.) Positive locking
in both directions with easy release catches.
Can be used for file drawer cabinets, CPU
Equipment ETC.. **WEIGHT: 12 LBS.**
ORIGINAL LIST PRICE \$39.95/PAIR
BRIGAR CLOSEOUT PRICE
..... \$7.95 PER PAIR

NEW

COMPUTER PRODUCTS

POWER CONVERSION

CONVERTERS

COMPUTER PRODUCTS

MODEL # EM951S

5-9W DC/DC CONVERTERS

- PI INPUT FILTER
- 500V ISOLATION
- SHORT CIRCUIT PROTECTED
- HIGH EFFICIENCY - 75%
- NON-CONDUCTIVE PLASTIC ENCLOSURE

2" X 2" X 0.4" PACKAGE

OUTPUT VOLTAGE ±12V/ ±375MA

INPUT VOLTAGE: 5VDC

REGULATION LINE: 1.2% LOAD 8%

REFLECTED RIPPLE: 75mA P-P

5 PIN PC MOUNTABLE

BRAND NEW FACTORY BOXED.

LIST PRICE \$82.00

BRIGAR SALE PRICE \$14.95 EA.



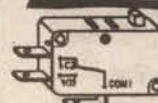
**DC-TO-DC
NEW**

**SLOW-SYN DC
STEPPING MOTOR**



STEPPING MOTOR
FUJI MODEL #GPF3945-2B
OR SANYO #103-820-2
"STEP - SYN" 4.5VDC,
1.4AMP 2 DEG STEP ANGLE
CLASS B WITH OPTICAL ENCODER.
45 PULSE PER REVOLUTION. 2 SETS
OF PULSES WITH PHASE OVERLAP
2 CENTER TAPPED WINDINGS.
(REMOVED FROM EQUIPMENT MINT CONDITION)
LIST PRICE \$45.00
BRIGAR PRICE ONLY \$6.95ea.

Crouzet



CROUZET # F83161.6
12AMP 250VAC
.187" QUICK CONN. TERM.
PHENOLIC PLUNGER ACT-
UATOR. SPDT
SALE PRICE ... 90¢

**hp HEWLETT
PACKARD**

GREEN RECTANGULAR LED
PART# HLMP-S500 DIFFUSED
SIZE: 5MM X 2MM 200,000 PCS. IN STOCK
SALE PRICE 100 @ .10EA. 1000 @ .05 EA.

NEW

FASTENERS & HARDWARE

MACHINE SCREWS TYPE SBH
BINDER HEAD
MACHINE SCREW
3-5.2 1/4" LONG ROUND HEAD SLOTTED
1000 pcs.
For \$7.00

ANALOG PANEL METERS

MULTIMETERS

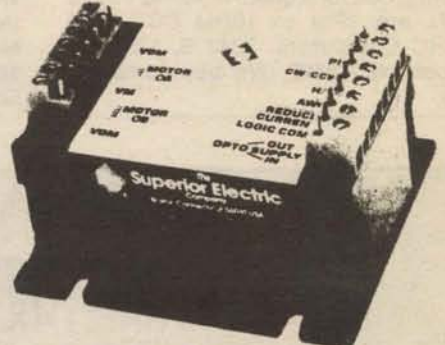
PHASTRON # 40-013857

ANALOG METER MOVEMENT
50 MICRO AMP D.C. FULL SCALE
LARGE 4.5" DIAMETER - MIL. SPEC.
PANEL METER 3.5" DIA. VIEWING AREA.
ZERO ADJUSTMENT KNOB. WHITE FACE.
SCALES: IN GREEN, BLACK, AND BLUE
LETTERS. THREE AC AND THREE DC
VOLT SCALES. 0 - 2.5, 5 AND 10. ONE
RESISTANCE SCALE FROM 0 TO INFINITY.
INCLUDES RUBBER GASKET, MOUNTING
HARDWARE. 1 1/4" BEHIND PANEL DEPTH
BRAND NEW FACTORY BOXED. NEW COST
\$40.00 EA. BRIGAR SALE PRICE \$6.95 EA.



Low Cost

Superior Electric



TYPE 230-T

SLO-SYN MICRO SERIES

TYPE 230-T 2A 30V

DESCRIPTION:

BI POLAR, 2 PHASE STEPPING
MOTOR DRIVE WITH TRANSLATOR
POWER SEMICONDUCTOR TYPE: H-BRIDGE
POWER IC TRANSLATOR: INTERNAL IC

PERFORMANCE:

RESOLUTION: HALF-STEP OR FULL STEP
STEP RATE: 0 TO 10,000 FULL STEPS/SEC
0 TO 10,000 HALF STEPS/SEC

CHOPPING FREQ: 20 kHz NOMINAL
SPEED/TORQUE: ALL SPECS USE TYPICAL
DATA

DIRECTION: CW/CCW

MOTOR COMPATIBILITY: M061-M092

NO OF LEADS: 4,6,8

SIZE: 3.15"L X 2.70"W X 1.31"H

WEIGHT: 1 LB

**BRAND NEW - INDIVIDUALLY FACTORY
PACKED. COMPLETE WITH INSTRUCTION
MANUAL AND SPEC SHEETS**

BRIGAR SPECIAL PRICE \$79.95

NEW

SALE



**Switching Power Supply
Multiple Output**

FULLY ENCLOSED - FAN COOLED

MFG: SHINDENGEN ELECTRIC CO.

PART# 130569SXD

INPUT: 115VAC 60HZ

OUTPUT 1: (RED) +5 VOLTS DC 10AMP

OUTPUT 2: (ORANGE) +12 VDC 1AMP

OUTPUT 3: (VIOLET) -5 VDC 0.1AMP

OUTPUT 4: (GREY) LOGIC SIGNAL + 3.25VDC

COMMON: (BLACK) 2.5VOLT WITH 1000 OHM

**FAN COOLED, EMI FILTERED AND ON-OFF SWITCH
USEFUL FOR EXTERNAL HARD DRIVE AND LOGIC
BREAD BOARDS.**

Size: 12"L x 3 1/2"W x 2" DEEP

Weight: 3 1/4 lbs. BRAND NEW FACTORY

PACKAGED. NEW COST \$75.00 EA.

BRIGAR SPECIAL SALE PRICE ONLY

\$14.95 EA.

NEW

#60 COMPUTER SOFTWARE *cont.*

ESTATE PLANNING Software, legal forms, power of attorney, etc. IBM PC compatible. Send \$1 for catalog to GD Enterprises, PO Box 292705, Ft. Lauderdale, FL 33329-2705.

COMPUTER EQUIPMENT WANTED

70

WE BUY computers and computer parts. No order too small or too big. We pay the shipping. Call for a quote at 402-421-3956. Hours are 1PM to 10PM CST. Call MSCRC Computers, 3243 S. 13th St., Lincoln, NE 68502. We buy computer stuff.

WE BUY transistors, diodes, semiconductors, integrated circuits. Electronic Material Industries, 818-842-5953, FAX 818-845-3613. Immediate offers.

WANTED: LAPTOPS dead/problem/old/etc., especially Toshiba. E-mail, or write: Eudoh@sct.edu, Etop Udoh, 3210 Hudson Rd., Marietta, GA 30060.

HEWLETT PACKARD equipment wanted, printers, plotters, peripherals, computers, accessories, large and small quantities. Computer Business Mart, Inc., 619-449-9041, FAX: 619-449-7929, E-Mail: 71221.1515@compuserve.com.

WANTED: MACINTOSHES: Ilici, PC486, laptop and better. Spectrum analyzers, electronic parts; laser printers; PC, MAC software. **CONSUMERTRONICS**, 2011 Crescent Dr., Alamogordo, NM 88310.

WANTED PROGRAMMER: Wanted EPROM and EEPROM programmer to \$100. Also want marine radios and ADF units. 408-867-2250.

WANTED: SOFTWARE and/or manual for an Everex Excel 60 F tape drive. Working Cipher 540/5400-540/5400 Plus, or any other tape drive "stuff." Bill Jackson, 10200 Parkwood Dr., Kensington, MD 20895.

I WANT it and I want it now. I want all of your SIMM memory. IBM, Mac, new, used, even defective. I want it all. Highest \$ paid. Call 1-800-4-MEMORY now! Voice/FAX.

TANDY/RADIO SHACK Model 1/3/4, 1000 Support. Monthly magazine, software, parts, repair. Computer News, POB 680, Casper, WY 82602. 307-265-6483.

WANTED: TERMINALS + PRINTERS: DEC, Wyse, IBM, ADDS, Okidata, Data South, Epson, C.I.T.O.H., etc. Call for quote on any surplus computer equipment. Call Jeremy, 603-673-8077.

DEC EQUIPMENT WANTED! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dialog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **COMPUTER KEYWAYS**, 513-847-2300 or FAX: 513-847-2350.

WANTED TO BUY IBM and Macintosh computers, printers, hard drives, peripherals, CPUs, notebooks any quantity, in working condition. Call 714-778-0450.

WANTED: 32 bit memory boards for ALR 386/220 computer. ALR part number 12406050. D.C. Harrington, 1620 Gardena Ave., Fridley, MN 55432. 612-571-0212.

POSTSCRIPT IDENTITY card for Epson Action Laser II. Mark Albanese, 107 Mari-ondale Drive, Plantsville, CT 06479.

PRINTHEADS WANTED. We buy all quantities of dot matrix printheads for hundreds of printer model types. Working or dead units acceptable. Call Mike Anderson @ 800-969-0009.

WANTED: COMPUTERS, parts to build, and software. Excess, used or obsolete stock. Any quantity. Anything computer related. Laptops, faxes, etc. 914-738-6830.

WANTED: PRE1980 Microcomputers for museum collection. Microcomputer magazines and manuals also needed. 703-231-6478, 703-763-3311.

WANTED: HP 65 CALCULATOR for parts. Call or write **HUGH ADAMS**, 904-864-2414, 1011-D Hondo Ave., Fort Walton Beach, FL 32547.

WANTED: APPLE I, Mark 8, Scelbi 8H, Scelbi 8B computers. 703-382-2935, 703-763-2321.

TEST EQUIPMENT

80

TEST EQUIPMENT FOR AUDIO, BROADCAST, VIDEO: Tek A6302 & AM 503 current probe & amplifier, DC to 50MHz \$890. Tek PG 508 50MHz pulse generator (variable rise, fall times) \$325. Tek DM 502A auto-ranging multimeter \$215. HP 3455A 6-1/2 digit multimeter \$550. HP 3456A 6-1/2 digit multimeter \$900. Tek AA 501 distortion analyzer \$1,295. Tek DA 4084 distortion analyzer (like AA 5001) \$1,395. HP 334A distortion analyzer \$395. Tek 466 100MHz portable storage oscilloscope \$850. Tek 485 350MHz portable oscilloscope \$795. Tek 7633 100MHz storage mainframe \$475. Tek 7A22 super high-sensitivity differential amplifier \$395. Tek 7854 400MHz oscilloscope mainframe with digital storage, waveform processing, GPIB \$1,075. Tek 7D20 digital storage plug-in featuring cursor measurements, min/max enveloping, signal averaging \$875. Excellent condition, with warranty. **Pepper Systems**, 214-353-0257.

WANTED: GENERAL RADIO model 815 or 816 clock, model 1103 or 1123 Synchrometer/clock. Call Bill Scolnik, 1-800-634-7036.

WANTED: LATE MODEL TEST EQUIPMENT (Tektronix, HP, Fluke). Especially: Tek SG 505/2, Tek S-6, Tek 2465A/B. Also, test equipment service manuals needed. **Pepper Systems**, 214-353-0257; 214-902-9511 FAX.

DANBAR SALES COMPANY

14455 N. 79 TH ST. UNIT #C, SCOTTSDALE, AZ 85260

(602) 483-6202 FAX (602) 483-6403

QUALITY USED ELECTRONIC TEST EQUIPMENT

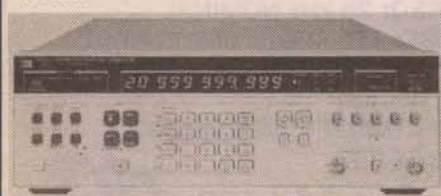
Hewlett-Packard 8620C/ 86222B

Sweep Oscillator Mainframe with RF Plug-In. The 8620C mainframe has option 011 HP-IB frequency programming. HP 86222B can provide CW or continuous swept 10 MHz to 2.4 GHz frequency coverage. Has option 002 70 dB step attn. and option 004 rear panel RF output.

\$ 2700.00

Hewlett-Packard 3325A

Synthesizer/ Function Generator, 1 uHz to 21 MHz, 11 digit resolution, sweeper, programmable.



\$ 2500.00

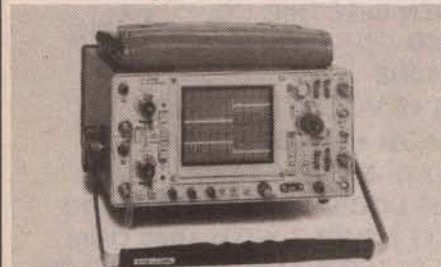
Hewlett-Packard 3455A

A microprocessor controlled voltmeter that measures DC volts (0.1 to 1000 V in 5 ranges), AC volts (0.1 to 1000 V in 5 ranges), and resistance. HP-IB, auto cal and self-test.

Special \$ 795.00

Tektronix 475 Scope Package

200 MHz BW, 2 mV/div sensitivity, 1 nS/div sweep rate, delaying timebase, trigger view and beam finder. Includes 2 new Probe Master Probes and a operators manual.



Special \$ 900.00

Hewlett-Packard 1630D Logic Analyzer 43 channel analyzer provides timing analysis, state analysis and software performance analysis. Built in HP-IB and HP-IL.

\$ 1250.00 Special Savings

Wandel & Goltermann TSA-1

Transmission System Analyzer, 100 Hz to 180 MHz, spectrum analysis, selective level, demodulation, phase jitter.



\$ 2250.00 Special

Same as above but includes network analyzer

\$ 2750.00 Special

Tektronix P6022 Current Probe * NEW *

Current Probe with Termination, 935 Hz to 200 MHz, clip on probe. Sensitivity 1 mA/mV or 10 mA/mV.

\$ 120.00 New Packaged

Hewlett-Packard 141T/ 8552B/ 8553B

Spectrum Analyzer system. The 141T mainframe features easy to read 8 x 10 cm variable persistence and storage. The 8552B/ 8553B IF and RF section feature a tuning range from 1 kHz to 110 MHz, with 18 calibrated scan widths from 20 Hz/div to 10 MHz/div in 1, 2, 5 sequence. Amplitude range is -140 to 10 dB. BW are adjustable from 10 Hz to 300 kHz.

\$ 1750.00

Hewlett-Packard 141T/ 8555A/ 8552B

Spectrum Analyzer System. The 141T Mainframe provides variable persistence and storage. The 8555A Tuning Section offers multiband coverage from 10 MHz to 18 GHz with internal mixers, 16 calibrated scan widths from 2 kHz/div to 200 MHz/div in 2, 5, 10 sequence. Amplitude range -127 to 10 dBm.

\$ 2500.00

WANTED:

ELECTRONIC TEST EQUIPMENT!
PLEASE CALL OR FAX US A LIST.

Hewlett-Packard 8620C/ 86290B

Sweep Oscillator Mainframe with RF Plug-In. The 8620C mainframe has option 011 HP-IB frequency programming. HP 86290B offers continuous sweep from 2 to 18.6 GHz in four ranges. Has option 004, rear panel RF output. Output of +9.5 dBm, power level control range of 10 dBm.

Special \$ 2900.00

Hewlett-Packard 8559A/ 853A

Digital Display Mainframe and Spectrum Analyzer plug-in. .01 to 21 GHz, -111 to +30 dBm amplitude range, 1 kHz to 3 MHz resolution BW.



\$ 6750.00

Hewlett-Packard 3336B

Synthesized/ Level Generator is an excellent precision source from 10 Hz to 20.9 MHz, frequency resolution .001 Hz, level accuracy within .15 dB over full range. AM and phase modulation. Fully programmable over HP-IB, harmonics down more than 5 dB.

Special \$ 650.00

Hewlett-Packard 3586B

Selective Level Meter, makes carrier measurements to 32.5 MHz. Voice channel measurements from 50 Hz to 100 kHz, can use HP 3336B as an automatic tracking generator.

\$ 850.00

Buy both together as a set for

\$ 1300.00

Hewlett-Packard 8559A

Spectrum Analyzer Plug-In, 0.01 to 21 GHz, -111 to +30 dBm, 0 to 70 dB input attenuator, 1 kHz to 3 MHz resolution BW.

\$ 4500.00

Hewlett-Packard 1725A/ 034

275 MHz Oscilloscope, 10 mV/div to 5 V/div vertical deflection factor, 10 nS max sweep rate, expandable to 1 nS/div. Option 034 adds DMM which measures voltage, current and resistance. Comes with 2 probes and an operators manual.

\$ 895.00

TEKTRONIX 7000 SERIES: 7854 400MHz oscilloscope mainframe with GPIB, digital storage, waveform measurement capability \$1,075. 7633 100MHz storage mainframe \$475. 7904 or R7903 500MHz mainframe \$435. 7A13 105MHz differential comparator amplifier (LED) \$395. 7A18 75MHz dual-trace amplifier \$65. 7A22 1MHz high-sensitivity differential amplifier \$395. 7A24 400MHz dual-trace amplifier \$325. 7A26 200MHz dual-trace amplifier \$150. 7A42 350MHz 4-channel amplifier \$595. 7D15 225MHz counter/timer \$275. 7D20 digital storage plug-in featuring cursor measurements, min/max enveloping, signal averaging \$875. 7L5/L3, 025 spectrum analyzer, 20Hz-5MHz, digital storage, tracking generator \$2,500. 7B53A 100MHz dual time base \$190. 7B92A 500MHz dual time base \$325. 7S12 time domain reflectometer with S-6, S-52, can measure distance to resolution of .1" (20 psec) per division! \$1,600. 7S14 1GHz dual trace delayed sweep sampler \$675. Excellent condition! Other plug-ins, mainframes, package discounts available. All with warranty. **Pepper Systems**, 214-353-0257.

WANTED: TRUETIME GOES SYNCHRONIZED CLOCK model 468, **OMEGA SYNCHRONIZED CLOCK** model OM-DC or what have you? Must be complete. Call Bill Scolnik, 1-800-634-7036.

SPECTRUM ANALYZERS FOR AUDIO, BROADCAST, VIDEO: HP 3582A dual-channel real-time FFT spectrum analyzer .02Hz to 25.5KHz \$3,300. HP 3580A spectrum analyzer, 5Hz through 50KHz, 1Hz resolution bandwidth, digital storage, adaptive sweep, tracking generator \$1,795 (LED display), \$1,395 (mech display). Anritsu MS420B powerful spectrum/network analyzer, 10Hz through 30MHz, 3Hz resolution bandwidth, digital storage, tracking generator \$2,850. **Wandel & Goltermann SBA-1** single sideband analyzer, with TSA-1 and SBG-1: powerful spectrum/network analyzer, 100Hz to 180MHz, 3Hz resolution bandwidth, digital storage, built-in demodulator, wide-band and selective level, tone search \$2,950. Tek 7L5/L3, 025 spectrum analyzer, 20Hz-5MHz, digital storage, tracking generator \$2,500. Excellent condition, with warranty. **Pepper Systems**, 214-353-0257.



HEWLETT PACKARD 5245L counters are all gone, but **PRETESTED REPAIR PARTS ARE STILL AVAILABLE:** Readout with Nixie, \$14.95. A17 card, \$14.95. Other cards, \$9.95. Nixies, \$7.50. Xtal oven assy, \$39. Add \$5 shipping. Send stamped addressed envelope for quote on any other part. Check/MO plus part number/description to: **TURCOTRONIX**, 1000 E. 14th, Suite 429A, Plano, TX 75074.

SUMMER'S END CLEARANCE: Acme PS2L-1000 Electronic Load \$275, BIO K-100D Logic Analyzer w/probes \$195, DIO 121A Gang Programmer \$495, DIO 29B w/Gang Pak \$295, Fluke 8012A w/ battery option \$149, HP 1744A 100MHz analog storage scope \$495, HP 1980B 100MHz digitizing scope \$495, HP 5345A 500MHz counter 500MHz counter \$450, HP 8620C sweeper mainframe \$350, Philips PM3311 60MHz 125 Ms/S digital storage scope \$595, TR503 tracking generator \$1295, Tek 465 100MHz scope \$425, Tek P6202A 500MHz FET probe \$195, P6230 1.5GHz FET probe \$195. Many more items! Call **TEST EQUIPMENT SALES**, 603-434-2544.

FLUKE 1900A \$100, Valhalla 2009 precision buffer amp \$50, Tektronix S1 \$100, Wavetek 159 function generator with GPIB \$250, HP 333A \$225, HP 331A \$150, HP 3455A DVM \$375, HP 213B \$100, HP 8441A \$100, HP 3300A \$100, Austron 2010B disciplined quartz standard \$450. 805-736-0288.

CUSHMAN CE 50A-1 Communications Monitor, 0-1000 MHz, spectrum analyzer, complete with all accessories. New battery. Still under current Cushman factory calibration. Like new condition. \$4,000. also, 5 E.F. Johnson 8700 LTR trunking mobile radios with accessories. \$200 each. Call 714-443-9322.

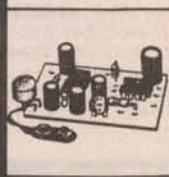
OSCILLOSCOPE MEASUREMENT System HP 1980B + univ. counter 1965A \$2,250/OFFER. DEXIS, 612-944-7670.

VOLTAGE REGULATOR. New in box precision automatic 6KVA 120 volt STACO TYPE 095-0349 one quarter of one percent accurate on output. \$200 plus shipping. 20 amp 0/120/140 VARIAC Model W-20 \$50. 8.5 amp 0/120 volt VARIAC Model W5L \$25 plus shipping. Variacs pulled from unused equipment. Have 8 each of VARIACS, with knobs. Send \$5 for manual of Voltage Regulator. Refundable on purchase. Write John Bartholomew, 519 Lower Terrace, Huntington, WV 25705.

HP 652A OSCILLATORS, 10Hz-10MHz, newer color with manual \$185. Interstate P-23 **PULSE GENERATORS** \$150. Warranty. 619-439-1345, 1-800-862-8983.

TEKTRONIX 1360P, Programmable switch \$200; TEK 7904 w/7AS12, 7A18, 7B70, 7B71 \$535, tested and working. Tektronix 7633 storage scope w/model 3 cart all in new condition \$437. 466 Portable Storage scope \$575; 7904 or 7704A, \$245. 7A11, \$115; 7D11 \$185, 7B53A \$125, 7B92A \$195, 7A26 \$140, 7S12 \$450. Others available, call for details. TM 501, TM 5005, DC 502, DC 504; 1101A \$88 as new, P6015 \$190. Psitech Plus, 707-745-4804, FAX: 707-745-1060.

RAINBOW KITS



SUPER SNOOPER BIG EAR

Listen through walls, hear conversations across the room. Add a parabolic reflector & hear blocks

away. The BIG EAR can be hidden about anywhere. Makes an ultra-sensitive intercom. Can be used as a 1.5W AMP. We supply a mini-electret mike in the kit. 1"x1.75" 6 to 12vDC
AA-1 **\$10.95**



PHONE TRANSMITTER

Small but mighty, it fits anywhere. Phone line powered, never needs batteries. Transmits both sides of a phone conversation loud and clear, wireless, to any FM radio at great distances. Variable tunes from 70MHz TO 130MHz FM. You can also use it as a speaker phone. Size .5"x1"

TEL-B1 **\$12.95**



PHONE RECORDING SWITCH

This phone line powered switch is small enough to be installed anywhere. Every time the phone is picked up the recorder will record both sides of the conversation automatically. Use it in your office to record all phone calls so you don't lose important information. 1"x.6"

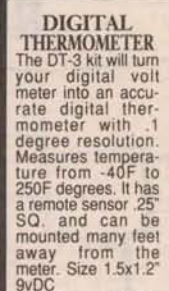
TEL-SW1 **\$12.95**



STROBE LIGHT

If you need an attention getter, warning light, or flashing light for model airplanes, then this kit is for you. Use it as an emergency light for your auto, radio tower, even use it on your bicycle. Has a variable flash rate. Size 3.5"x1.8" operates on 6 or 12v DC only.

ST-1 **\$9.95**



DIGITAL THERMOMETER

The DT-3 kit will turn your digital volt meter into an accurate digital thermometer with .1 degree resolution. Measures temperature from -40F to 250F degrees. It has a remote sensor .25" SQ. and can be mounted many feet away from the meter. Size 1.5x1.2" 9vDC

DT-3 **\$8.95**

CAPACITANCE METER

This kit will turn your digital volt meter into a capacitance meter. Turn that junk box of unmarked capacitors into a fortune of usable parts. Measures capacitors from <2.2pF to 2.2uF. 1.75"x2" 9vDC

CA-1 **\$12.95**

TEMPERATURE GENIE

Ever lost frozen food because your freezer stopped? The TC-2 kit would have saved you money. An alarm activates when the temp. reaches that critical degree. Turn ceiling fans on automatically when it gets too hot. This kit gives you 100MA of output. 1.5"x1.2" 6 to 15vDC

TC-2 **\$7.95**

LIGHT GENIE

Turn anything on or off with light, night light, security lights, turns on at night off at daylight automatically. As the light touches or leaves the sensor it delivers 100 MA of output to run a relay. Size 1.5"x1.2" 6 to 15vDC

LG-2 **\$7.95**

CHASER LIGHTS

Use this kit like a theater marquee. Every forth led chases around the display to give you a dazzling effect. You can use 40 led's around badges, pictures, hats, belts, signs, only your imagination limits the possibilities. Kit supplied with 16 leds. SIZE 1.3"x1.6" 4 to 9vDC

CL-1 **\$15.95**

BUSY PHONE LIGHT

Add this little kit to any or all of your phones. When one phone is in use an LED will light on the other extension. This lets everyone know when your computer modem is in use. Requires 9vDC 1"x1/2"

TEL-LITE **\$9.95**



RADAR SIGNAL DETECTOR

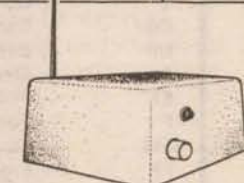
The RSD-1 kit won't replace a \$200.00 unit but this simple yet effective detector circuit can be built in less than an hour and can be tuned to respond to signals from 50MHz to 500GHz. We supply a lighter plug. 1"x1.75" 9 to 15vDC

RSD-1 **\$12.95**

LIQUID LEVEL DETECTOR

Use this kit to turn on a relay for a sump pump. Add this to your security system to turn on an alarm when water reaches a certain level. This kit will give you 100MA of output. Size 1.5"x1.2" 9vDC

LL-1 **\$9.95**



With the FMST-100,

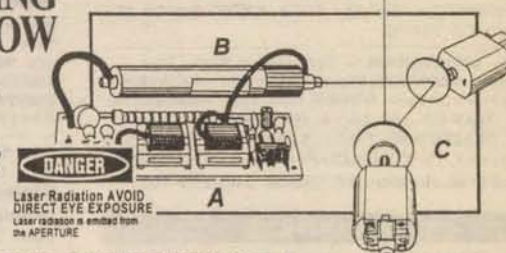
you have a wireless link to Any FM stereo radio. Transmit your CD player while mowing the lawn, from your camper to your car, through out an auditorium, around the neighborhood, even transmit music on one channel and sing

on the other. Compatible with any of your audio equipment. The clarity is excellent, uses a crystal for approximately 40dB of stereo separation. The length of antenna determines how long it transmits. The output is tuneable from 76 to 108MHz FM. Comes with a left & right input level adjust. operates on 9vDC. 1.5"x1.6"

FMST-100 Enclosure **\$29.95 \$ 8.95**

EXCITING RAINBOW LASER KITS

ALL 3 FOR **\$99.95**



LASER SWITCHING POWER SUPPLY KIT A

Input 12vDC 1A, Output 2 to 3KV at 3-4.5ma. trigger voltage of approx. 8-10KV. Complete with P.C. Board 6.25"x 2.25" schematic & all parts.

LPS-1 **\$59.95**

1MW He-Ne LASER TUBE B

Approx. 1"x 5.75" perfect for experimenters laser projects. Works great with LPS-1 power supply.

L1MN-1 **\$39.95**

MIRROR MOTOR KIT C

Project Lissajous patterns on the walls. Change the patterns by changing the speed of the motors. Comes complete with 2 motors, 2 front surface mirrors, mounting brackets, & speed control.

MM-2 **\$19.95**

TV NOTCH FILTERS

For channels 2 thru 22 ONLY



Our TV filters eliminate unwanted TV channels or interference that alters both sound and video with a beep-beep-beep. Works on cable channels 2 thru 22 and the 'SNOOPER & BULLET'.

NOTE: All TV Filter Kits are sold for educational purposes only. You must obtain permission from your local cable company before using these filters on your cable system.

DF222 Kit **\$14.95**

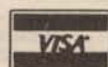


This Manual contains all schematics, parts & P.C. board layouts for all of the Rainbow Kits. Use your own parts to construct any of our kits.

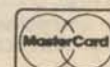
KIT BOOK **\$14.95**
\$5.00 off if you buy any kit

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ELECTRONIC RAINBOW

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WESTERN REGION

NOVEMBER 5

AZ - TEMPE — Fall Swap Meet & Auction. **SPONSOR:** Arizona Antique Radio Club. **LOCATION:** Antique Electronic Supply, 6221 S. Maple Ave., parking lot. **HOURS:** 7am-11am. **CONTACT:** Martin Bergan, 602-248-0356.

CA - FRESNO — MarketPro Computer Show & Sale. **LOCATION:** Holiday Inn. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

CA - SANTEE — Ham Radio, Computer & Electronics Swap Meet. **SPONSOR:** Amateur Radio Club of El Cajon. **LOCATION:** Santee Drive-In, 10990 N. Woodside. **OPENS:** Appx. 6:30am, rain or shine. **ADMISSION:** 50 cents. **TALK-IN:** 146.520. **FEATURES:** C-E-F-F/R-H. **DEALER INFO:** \$6/vehicle. **CONTACT:** N6RGM Sonny, 619-444-6532; WA6MHZ Pat, 619-561-0052; ARCEC, Box 50, El Cajon CA 92020.

WA - BELLINGHAM — Bellingham Radio Flea Market. **SPONSOR:** Mount Baker ARC. **LOCATION:** Bay Horizon Park. **HOURS:** 9am-4pm. **ADMISSION:** \$3. **TALK-IN:** 146.74/14. **FEATURES:** C-EX-FP-F/R. **DEALER INFO:** Tables: \$15 before Oct. 15, \$20 after Oct. 15. **CONTACT:** Al Norton, K7IEY, 1008 Liberty St., Lynden WA 98264. 206-354-4622.

NOVEMBER 5-6

CA - SACRAMENTO — MarketPro Computer Show & Sale. **LOCATION:** Cal Expo. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

NOVEMBER 6

CA - LIVERMORE — East Bay Area Amateur Radio/Electronics/Computer Swap Meet **SPONSOR:** Livermore Amateur Radio Klub (LARK). **LOCATION:** Los Positas College, N of I-580 at Airway Blvd. exit. **HOURS:** 7am-noon, rain or shine. **ADMISSION:** Free. **TALK-IN:** 147.045 + fr west, 145.350- (100Hz) fr east. **FEATURES:** E-H-FP-F/R. **DEALER INFO:** Setup after 6am only. \$10 space fee. Covered spaces avail. If rain. **CONTACT:** Noel Anklam KC6QZK, 510-447-3857 eves or 510-783-2803 message days.

CA - OXNARD — MarketPro Computer Show & Sale. **LOCATION:** Community Center. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

NOVEMBER 12

CA - FONTANA — Amateur Radio & Electronic Equipment Swap Meet. **SPONSOR:** Inland Empire ARC & A.B. Miller High School ARC. **LOCATION:** A.B. Miller High School, 6821 Oleander Ave.

CA - SANTA ROSA — MarketPro Computer Show & Sale. **LOCATION:** Sonoma Co. Fairgrounds. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

OR - HILLSBORO — Northwest Computer Show & Sale. **SPONSOR:** Access Marketing. **LOCATION:** Hillsboro Fairplex. **HOURS:** 9am-4pm. **ADMISSION:** \$4, under 12 free. **FEATURES:** C-DP-FP-F/R. **CONTACT:** Access Marketing, 206-573-4301.

NOVEMBER 12-13

CA - WESTWOOD — Computer Show. **SPONSOR:** American Mega Shows. **LOCATION:** UCLA, Grand Ballroom. **HOURS:** 10am-5pm. **ADMISSION:** \$6, \$1 off w/coupon or ad. **FEATURES:** C. **CONTACT:** American Mega Shows, 818-961-3782.

NOVEMBER 13

CA - LANCASTER — MarketPro Computer Show & Sale. **LOCATION:** Antelope Valley Fairgrounds. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

CA - SAN RAFAEL — MarketPro Computer Show & Sale. **LOCATION:** Marin Civic Center. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

NOVEMBER 19

CA - SANTEE — Ham Radio, Computer & Electronics Swap Meet. **SPONSOR:** Amateur Radio Club of El Cajon. **LOCATION:** Santee Drive-In, 10990 N. Woodside. **OPENS:** Approx. 6:30am, rain or shine. **ADMISSION:** 50 cents. **TALK-IN:** 146.520. **FEATURES:** C-E-F-F/R-H. **DEALER INFO:** \$6/vehicle.

Events CALENDAR

The Events Calendar is a free service limited to electronic events such as computer shows, hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days prior to the event. Include your flyer, estimated attendance, name of person to contact and phone number. Complimentary issues are available upon request for distribution to your attendees. A street address for UPS shipment is required.

While we strive for accuracy in our calendar, we cannot be responsible for errors or cancellations. The information contained in this column is for the use of the readers of Nuts & Volts and may not be republished in any form without the written permission of T & L Publications, Inc.

CONTACT: N6RGM Sonny, 619-444-6532; WA6MHZ Pat, 619-561-0052; ARCEC, Box 50, El Cajon CA 92020.

NOVEMBER 20

AZ - PHOENIX — Computer & Electronic Swap Meet. **SPONSOR:** Electronic Materials & Computers. **HOURS:** 8am-3pm. **ADMISSION:** Free. **FEATURES:** FP. **DEALER INFO:** Vendor spaces \$15. **CONTACT:** 3102 W Thomas Rd. #902, Phoenix AZ 85017. 602-272-3200.

CA - STOCKTON — MarketPro Computer Show & Sale. **LOCATION:** Stockton Civic Auditorium. **HOURS:** 9am-3pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

NOVEMBER 26

CA - VALLEJO — MarketPro Computer Show & Sale. **LOCATION:** Solano Co. Fairgrounds. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

NOVEMBER 26-27

CA - SAN DIEGO — MarketPro Computer Show & Sale. **LOCATION:** Scottish Rite Center. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

NOVEMBER 27

CA - SACRAMENTO — MarketPro Computer Show & Sale. **LOCATION:** Scottish Rite Center. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

CA - SANTA ANA — ACP Computer Swap Meet. **SPONSOR:** Advanced Computer Products. **LOCATION:** 1310 E. Edinger. **HOURS:** 8am-2pm, rain or shine. **ADMISSION:** Free. **FEATURES:** C-E-FP. **DEALER INFO:** All spaces \$75 in advance. Call for multiple pricing. **CONTACT:** Mary Russo - 714-558-8813.

DECEMBER 3

AZ - MESA — Hamfest '94. **SPONSOR:** Superstition ARC. **LOCATION:** Mesa Community College, SE corner of Dobson & Southern, I-60 Dobson Rd. exit. **HOURS:** 7am-3pm. **ADMISSION:** \$2 per car, tailgate admission \$5/2 spaces. **TALK-IN:** 147.12 +, 449.025- 100HzPL. **FEATURES:** DP-T. **DEALER INFO:** Commercial vendors \$10/4 spaces. **CONTACT:** Tom Stafford, KB7QVV, 602-671-0635.

CA - SANTA ROSA — MarketPro Computer Show & Sale. **LOCATION:** Sonoma Co. Fairgrounds. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

CA - SANTEE — Ham Radio, Computer & Electronics Swap Meet. **SPONSOR:** Amateur Radio Club of El Cajon. **LOCATION:** Santee Drive-In, 10990 N. Woodside. **OPENS:** Appx. 6:30am, rain or shine. **ADMISSION:** 50 cents. **TALK-IN:** 146.520. **FEATURES:** C-E-F-F/R-H. **DEALER INFO:** \$6/vehicle. **CONTACT:** N6RGM Sonny 619-444-6532; WA6MHZ Pat 619-561-0052; ARCEC, Box 50, El Cajon CA 92020.

CA - VENTURA — MarketPro Computer Show & Sale. **LOCATION:** Ventura Fairgrounds. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

DECEMBER 4

CA - LANCASTER — MarketPro Computer Show & Sale. **LOCATION:** Antelope Valley Fairgrounds. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

CA - LIVERMORE — East Bay Area Amateur Radio/Electronics/Computer Swap Meet **SPONSOR:** Livermore Amateur Radio Klub (LARK). **LOCATION:** Los Positas College, N of I-580 at Airway Blvd. exit. **HOURS:** 7am-12noon, rain or shine. **ADMISSION:** Free. **TALK-IN:** 147.045 + fr west, 145.350- (100Hz) fr east. **FEATURES:** E-H-FP-F/R. **DEALER INFO:** Setup after 6am only. \$10 space fee. Covered spaces avail. If rain. **CONTACT:** Noel Anklam KC6QZK, 510-447-3857 eves or 510-783-2803 message days.

DECEMBER 10

CA - FONTANA — Amateur Radio & Electronic Equipment Swap Meet. **SPONSOR:** Inland Empire ARC & A.B. Miller High School ARC. **LOCATION:** A.B. Miller High School, 6821 Oleander Ave.

DECEMBER 10-11

CA - SACRAMENTO — MarketPro Computer Show & Sale. **LOCATION:** Cal Expo. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

DECEMBER 17

CA - SANTEE — Ham Radio, Computer & Electronics Swap Meet. **SPONSOR:** Amateur Radio Club of El Cajon. **LOCATION:** Santee Drive-In, 10990 N. Woodside. **OPENS:** Appx. 6:30am, rain or shine. **ADMISSION:** 50 cents. **TALK-IN:** 146.520. **FEATURES:** C-E-F-F/R-H. **DEALER INFO:** \$6/vehicle. **CONTACT:** N6RGM Sonny 619-444-6532; WA6MHZ Pat 619-561-0052; ARCEC, Box 50, El Cajon CA 92020.

All listing information should be sent to:

**Nuts & Volts Magazine
EVENTS CALENDAR
430 Princeland Court
Corona, CA 91719
Phone 909-371-8497
FAX 909-371-3052**

DECEMBER 17-18

CA - DEL MAR — MarketPro Computer Show & Sale. **LOCATION:** Del Mar Fairgrounds. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

CA - NORTHRIDGE — Computer Show. **SPONSOR:** American Mega Shows. **LOCATION:** Cal. State Northridge, San Fernando Valley Hall. **HOURS:** 10am-5pm. **ADMISSION:** \$6, \$1 off w/coupon or ad. **FEATURES:** C. **CONTACT:** American Mega Shows, 818-961-3782.

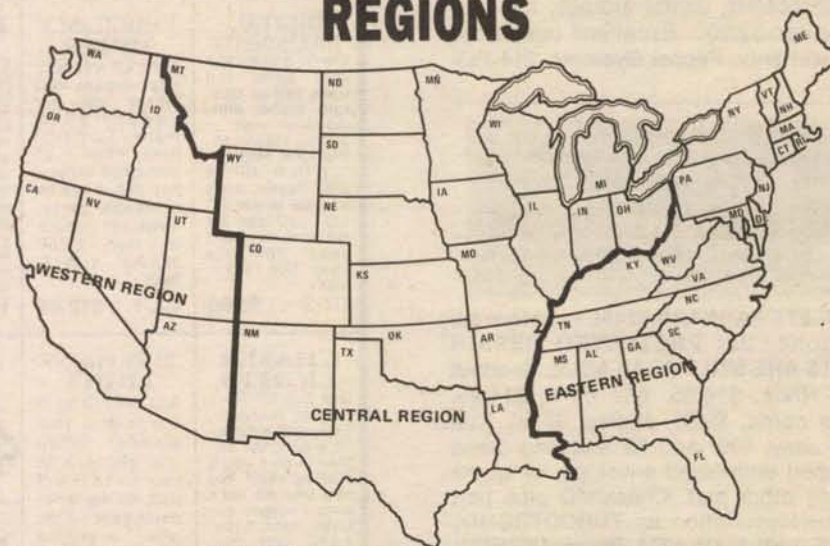
CA - OXNARD — MarketPro Computer Show & Sale. **LOCATION:** Community Center. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

CA - VALLEJO — MarketPro Computer Show & Sale. **LOCATION:** Solano Co. Fairgrounds. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

JANUARY 1

CA - LIVERMORE — East Bay Area Amateur Radio/Electronics/Computer Swap Meet **SPONSOR:** Livermore Amateur Radio Klub (LARK). **LOCATION:** Los Positas College, N of I-580 at Airway Blvd. exit. **HOURS:** 7am-12noon, rain or shine. **ADMISSION:** Free. **TALK-IN:** 147.045 + fr west, 145.350- (100Hz) fr east. **FEATURES:** E-H-FP-F/R. **DEALER INFO:** Setup after 6am only. \$10 space fee. Covered spaces avail. If rain. **CONTACT:** Noel

REGIONS



FEATURES KEY

AC	— Air-conditioned
B	— Banquet
C	— Computers
CB	— Commercial Booths
DP	— Door Prizes
E	— Electronics
EX	— FCC exams
F	— Forums
FM	— Flea Market
FP	— Free Parking
F/R	— Food & Refreshments
H	— Amateur Radio
RV-H	— RV Parking w/hookups
RV-S	— RV Parking Self-contained
S	— Seminars
T	— Tailgating

COMPUTER SHOW PROMOTER INFO

AGI Computer Fair - 317-299-8827
CMA Computer Shows - 804-272-1570
KGP Computer Shows - 908-297-2526
MarketPro Computer Shows - 415-388-8893
NARISAAM Computer Shows - 404-565-9889
800-436-6707
Northern Computer Shows - 508-744-8440
Peter Trapp Shows - 607-369-2796

Events CALENDAR

Anklam KC6QZK, 510-447-3857 eves or 510-783-2803 message days.

JANUARY 15

AZ - PHOENIX — Computer & Electronic Swap Meet. **SPONSOR:** Electronic Materials & Computers. **HOURS:** 8am-3pm. **ADMISSION:** Free. **FEATURES:** FP. **DEALER INFO:** Vendor spaces \$15. **CONTACT:** 3102 W Thomas Rd. #902, Phoenix AZ 85017. 602-272-3200.

CENTRAL REGION

NOVEMBER 5

IN - INDIANAPOLIS — Indianapolis Computer Fair. **LOCATION:** Quality Inn East, 35th St. & Shadeland Ave., near Pendleton Pike. **HOURS:** 10am-3pm. **ADMISSION:** \$4. **FEATURES:** C - DP. **CONTACT:** Ben Yanto, AGI Computer Fairs.*

MI - ROSEVILLE — International Canadian/American Mega-Fest Show. **SPONSOR:** E.S.P.S. Corp. **LOCATION:** Days Inn Hotel, 31960 Little Mack. I-94 to Gratiot, go to Masonic, make right, 1/4 mile on right. **HOURS:** 10am-4pm. **ADMISSION:** \$4. **FEATURES:** C - CB - H. **DEALER INFO:** Setup 8am-9:45am. **CONTACT:** John or Sabrina, Bus: 313-884-7690/FAX.

MI - TAYLOR — Computer Trade Show. **LOCATION:** Democratic Club of Taylor, 23400 Wick Rd., 4 blocks E of Telegraph. **HOURS:** 10am-3pm. **ADMISSION:** Adults \$4; Seniors & students w/ID \$3; under 12 free w/adult. **FEATURES:** C - DP. **CONTACT:** Computers & You, 313-283-1754.

OK - ENID — Hamfest. **SPONSOR:** Enid Hamfest Group. **LOCATION:** Garfield County Fairgrounds, Oxford & 4th St. **HOURS:** 8am-5pm. **ADMISSION:** \$2. **TALK-IN:** 147.375 + .444.825 +. **FEATURES:** B - EX - F/R. **DEALER INFO:** Tables \$1 each. **CONTACT:** Tom Worth, 2302 Eucalyptus Ave., Enid OK 73701. 405-233-8473.

TX - SULPHUR SPRINGS — Northeast Texas Fall Hamfest. **SPONSOR:** Hopkins County ARC & RAILS. **LOCATION:** Hopkins County Regional Civic Center. **HOURS:** 8am-2pm. **ADMISSION:** \$4 adv., \$5 door, under 13 free. **TALK-IN:** 146.68-(151.4) & 444.825+(151.4). **FEATURES:** EX - F/R. **DEALER INFO:** \$10 first table, \$5 ea. additional table, electricity available. Setup Fri. 7pm-9pm & Sat. 6am. **CONTACT:** Hopkins County ARC c/o Nathan Bailey, 1510 San Jacinto, Sulphur Springs TX 75482. 903-885-3555 after 7:30pm Central.

WI - WAUKESHA — 10th Annual Friendlyfest '94. **SPONSOR:** Milwaukee Repeater Club, Inc. **LOCATION:** Waukesha County Expo Center Arena, N1 W24848 Northview Rd. **HOURS:** 8am-1pm. **ADMISSION:** \$3 adv., \$4 door. **TALK-IN:** 146.31/146.91, 146.52. **FEATURES:** C - E - EX - F/R - H. **DEALER INFO:** Setup 6am. Tables adv. \$4, \$5 door. Electricity \$7.50. **CONTACT:** Burt, N9VB1, 414-328-0535 or send SASE to: Milwaukee Repeater Club, Inc., POB 2123, Milwaukee WI 53201.

NOVEMBER 5-6

OH - CINCINNATI — Cincinnati Computer Fair. **SPONSOR:** Trade Show Productions, Inc. **LOCATION:** Cincinnati Gardens, 2250 Seymour Rd. **HOURS:** Sat: 10am-5pm, Sun: 10am-3pm. **ADMISSION:** \$5, good for both days. **FEATURES:** C. **CONTACT:** 513-263-3378.

TX - ODESSA — 11th Annual Odessa Hamfest Convention. **SPONSOR:** West Texas ARC. **LOCATION:** Holiday Inn Convention Center, 6201 East Business I-20. **HOURS:** Sat: 8am-5pm, Sun: 8am-2pm. **ADMISSION:** \$7 adv., \$8 door. **FEATURES:** DP. **DEALER INFO:** Tables \$8. **CONTACT:** Robert Jordan, N5RKN, 915-335-7980 evenings.

NOVEMBER 6

IN - ANDERSON — Indianapolis Computer Fair. **LOCATION:** Holiday Inn, 5920 Scatterfield Rd., just off I-69. **HOURS:** 10am-3pm. **ADMISSION:** \$4. **FEATURES:** C - DP. **CONTACT:** Ben Yanto, AGI Computer Fairs.*

KY - LOUISVILLE — Computer Fair South. **SPONSOR:** MEKA Enterprises, Inc. **LOCATION:** Executive West Hotel, I-65 & 264 Freedom Way at the Fairgrounds. **HOURS:** 10am-3pm. **CONTACT:** William Ibarra, 2656 E. 2nd St., Bloomington IN 47401. 812-333-4484, FAX: 812-333-4650.

MI - MADISON HEIGHTS — Computer Trade Show. **LOCATION:** U&F Hall, 876 Horace Brown Dr., 1 block E of I-75, 3 blocks S of 13 Mile Road. **HOURS:** 10am-4pm. **ADMISSION:** Adults \$4; Seniors & students w/ID \$3; under 12 free w/adult. **FEATURES:** C - DP. **CONTACT:** Computers & You, 313-283-1754.

MI - SOUTHFIELD — Swap & Shop. **SPONSOR:** Oak Park ARC. **LOCATION:** Southfield Civic Center Pavilion, Evergreen Rd., between 10 & 11 Mile

Rds. **HOURS:** 8am-3pm. **ADMISSION:** \$5, under 12 free. **TALK-IN:** 146.64, 224.36. **FEATURES:** DP - F/R. **DEALER INFO:** 8' tables \$20. **CONTACT:** 810-559-2442.

MI - TAYLOR — International Canadian/American Mega-Fest Show. **SPONSOR:** E.S.P.S. Corp. **LOCATION:** Holiday Inn, 20777 Eureka Rd. I-75 to Eureka Rd. on E side of Fwy. **HOURS:** 10am-4pm. **ADMISSION:** \$4. **FEATURES:** C - CB - H. **DEALER INFO:** Setup 8am-9:45am. **CONTACT:** John or Sabrina, Bus: 313-884-7690/FAX.

MO - CARTHAGE — Hamfest. **SPONSOR:** Carthage ARS. **LOCATION:** Memorial Hall, Oak & Garrison Streets. **HOURS:** 8am-2pm. **ADMISSION:** \$3. **TALK-IN:** 147.42. **FEATURES:** C - EX - H. **DEALER INFO:** Tables \$5, call in advance if possible. **CONTACT:** Jim Dixon, WX0J, 417-358-4126.

OH - CLEVELAND — Computer Mania. **SPONSOR:** National Computer Exposition. **LOCATION:** Holiday Inn/Hudson, 240 Hines Hill Rd., at I-80 Ohio Tpk (N. Exit 12). **HOURS:** 10am-4pm. **ADMISSION:** \$1 off admission w/ad, under 12 free. **FEATURES:** FP. **DEALER INFO:** Setup 8am-10am. Sellouts are common, early booking advised. **CONTACT:** Joe Bowen, 216-442-1776 or Ronald Nelson, FAX: 216-292-7746. National Expo's, Inc., POB 24343, Cleveland OH 44124.

WI - KAUKAUNA — Ham & Computer Fest '94. **SPONSOR:** Fox Cities ARC. **LOCATION:** Starlite Club. **ADMISSION:** \$4. **TALK-IN:** 146.76-PL 107.2. **FEATURES:** C - DP - EX - H. **DEALER INFO:** Tables \$6, Setup 6am. **CONTACT:** Dan Vanevenhoven, N9LVS, 2410 E. Newberry, Appleton WI 54915. 414-739-5101.

NOVEMBER 12

LA - WEST MONROE — Hamfest. **SPONSOR:** Twin Cities Ham Club. **LOCATION:** West Monroe, LA Convention Center. **CONTACT:** Twin Cities Ham, POB 1871, West Monroe LA 71294-1871.

MI - KALAMAZOO — Computer Trade Show. **LOCATION:** Kalamazoo Co. Fairground, 2900 Lake St., E of (Bus. I-94). **HOURS:** 10am-3pm. **ADMISSION:** Adults \$4; Seniors & students w/ID \$3; under 12 free w/adult. **FEATURES:** C - DP. **CONTACT:** Computers & You, 313-283-1754.

NOVEMBER 13

CO - DENVER — Swap Meet/Meeting. **SPONSOR:** Colorado Radio Collectors. **LOCATION:** South West Bank Bldg., Community Room, 1380 S. Federal Blvd. **HOURS:** 1pm meeting, 3pm swap meet. **CONTACT:** Barney Wooters, 303-770-5314.

MI - DEARBORN — Computer Trade Show. **LOCATION:** Dearborn Civic Center, 15801 Michigan Ave., corner of Greenfield. **HOURS:** 10am-4pm. **ADMISSION:** Adults \$4; Seniors & students w/ID \$3; under 12 free w/adult. **FEATURES:** C - DP. **CONTACT:** Computers & You, 313-283-1754.

NOVEMBER 19

IN - MERRILLVILLE — Computer Possibilities Unlimited. **SPONSOR:** Bee Software. **LOCATION:** Michelangelo Hall, 6220 Broadway. **HOURS:** 10am-3pm. **ADMISSION:** \$5, under 12 free. **FEATURES:** AC - C - DP - F/R - S. **CONTACT:** Info/Discount tickets: 219-931-3761.

MI - HOLLAND — 4th Annual Westshore Hamfest/Computer Expo. **SPONSOR:** Holland ARC. **LOCATION:** Holland Christian H.S., 956 Ottawa Ave. **HOURS:** 8am-Noon. **FEATURES:** EX. **DEALER INFO:** Setup Fri. 8pm-10pm; Sat. 6:30am. **CONTACT:** Westshore Hamfest, c/o Joe Campbell, N8TGX, 10413 Northfield Dr., Holland MI 49424. 616-772-4928.

MI - LIVONIA — Computer Trade Show. **LOCATION:** Livonia Elks Lodge Hall, 31117 Plymouth Rd., 1 block E of Merriman. **HOURS:** 10am-3pm. **ADMISSION:** Adults \$4; Seniors & students w/ID \$3; under 12 free w/adult. **FEATURES:** C - DP. **CONTACT:** Computers & You, 313-283-1754.

MI - ROSEVILLE — International Canadian/American Mega-Fest Show. **SPONSOR:** E.S.P.S. Corp. **LOCATION:** Days Inn Hotel, 31960 Little Mack. I-94 to Gratiot, go to Masonic, make right, 1/4 mile on right. **HOURS:** 10am-4pm. **ADMISSION:** \$4. **FEATURES:** C - CB - H. **DEALER INFO:** Setup 8am-9:45am. **CONTACT:** John or Sabrina, Bus: 313-884-7690/FAX.

NM - SOCORRO — Hamfest. **SPONSOR:** Socorro ARS. **LOCATION:** City of Socorro. **LOCATION:** Finley Gym. **HOURS:** 9am-5pm. **TALK-IN:** 146.68. **FEATURES:** EX - FM. **CONTACT:** Dave, N1IRZ, 505-835-1218. Exam Info: Kalman, AJ5B, 505-835-5225.

NOVEMBER 19-20

IN - FORT WAYNE — Ft. Wayne Hamfest & Computer Expo/Indiana ARRL Convention. **SPONSOR:** Allen County Amateur Radio Technical Society. **LOCATION:** Allen County Memorial Coliseum on US 30. **HOURS:** Sat: 9am-4pm, Sun: 9am-3pm. **ADMISSION:** \$5, 11 & under free.

TALK-IN: 146.88-. **FEATURES:** C - CB - DP - EX - F - FM. **DEALER INFO:** \$15 flea market tables, \$30 premium tables, \$25 electricity. **CONTACT:** John Rufner, KB9BN1, 219-483-6305 (tables) or Don Gagnon, WB8HQS, 219-484-3317 (general questions) or write ACARTS, POB 10342, Ft. Wayne IN 46851.

NOVEMBER 20

IL - CHICAGO — Semi-Annual Surplus Electronic Auction. **SPONSOR:** Chicago ARC. **LOCATION:** The DeVry Institute of Technology, 3300 N. Campbell Ave. **HOURS:** Noon-7. **CONTACT:** Dean, 708-331-7764 morning or evening; or George, 312-545-4740 days.

IL - ORLAND PARK — The Orland Park Computer Show. **LOCATION:** Orland Park Civic Center, 147th St. & LaGrange Rd. (Rt. 45). **HOURS:** 9:30am-3pm. **ADMISSION:** Adults \$5 - \$1 off with copy of this ad, 8-12 yrs \$2, under 8 free. **FEATURES:** A - C - CB - DP - F/R - All Indoors. **CONTACT:** 24-hour Hotline 708-974-3123.

MI - FLINT — Computer Trade Show. **LOCATION:** Holiday Inn, 5353 Gateway Centre, exit at Hill Rd. from US-23 or I-475. **HOURS:** 10am-4pm. **ADMISSION:** Adults \$4; Seniors & students w/ID \$3; under 12 free w/adult. **FEATURES:** C - DP. **CONTACT:** Computers & You, 313-283-1754.

MI - TAYLOR — International Canadian/American Mega-Fest Show. **SPONSOR:** E.S.P.S. Corp. **LOCATION:** Holiday Inn, 20777 Eureka Rd. I-75 to Eureka Rd. on E side of Fwy. **HOURS:** 10am-4pm. **ADMISSION:** \$4. **FEATURES:** C - CB - H. **DEALER INFO:** Setup 8am-9:45am. **CONTACT:** John or Sabrina, Bus: 313-884-7690/FAX.

OH - CLEVELAND — Computer Mania. **SPONSOR:** National Computer Exposition. **LOCATION:** Airport Marriott Hotel, 4277 W 150th St. at I-71. **HOURS:** 10am-4pm. **ADMISSION:** \$1 off admission w/ad, under 12 free. **FEATURES:** FP. **DEALER INFO:** Setup 8am-10am. Sellouts are common, early booking advised. **CONTACT:** Joe Bowen, 216-442-1776 or Ronald Nelson, FAX: 216-292-7746. National Expo's, Inc., POB 24343, Cleveland OH 44124.

NOVEMBER 26

IL - LITCHFIELD — 8th Annual Television Banquet. **SPONSOR:** Central Illinois/St. Louis Area Amateur Television Club. **LOCATION:** Ariston Restaurant. **CONTACT:** Scott Millick, K9SM, 907 Big Four Ave., Hillsboro IL 62049-1009. 217-532-3837.

IN - EVANSVILLE — Evansville Winter Hamfest. **SPONSOR:** Electronic Applications Radio Service. **LOCATION:** Vanderburgh County Fairgrounds, I-64 to Hwy. 41 S. **HOURS:** 8am-2pm. **ADMISSION:** \$4. **TALK-IN:** 145.150, 146.925, 145.110. **FEATURES:** CB - FM - FP - F/R. **DEALER INFO:** Tables \$10. Setup Sat. 6am. **CONTACT:** Bev, KA9PDG, 812-479-5741 or write: EARS, 1506 S. Parker Dr., Evansville IN 47714.

MI - WATERFORD — Computer Trade Show. **LOCATION:** North Oakland Community Center, 5640 Williams Lake Rd., between Airport Rd. and railroad tracks. **HOURS:** 10am-3pm. **ADMISSION:** Adults \$4; Seniors & students w/ID \$3; under 12 free w/adult. **FEATURES:** C - DP. **CONTACT:** Computers & You, 313-283-1754.

MI - WESTLAND — Great Lakes Computer Expo & Sale. **SPONSOR:** Progressive Computer Productions. **LOCATION:** Wayne-Ford Civic League, 1645 Wayne Rd. I blk S of Ford Rd. **HOURS:** 10am-4pm. **ADMISSION:** Adults \$4, Seniors/Students \$3, under 12 free w/adult. **FEATURES:** C - DP - F/R - S. **DEALER INFO:** 8' \$30 ea, 12' \$40 ea. **CONTACT:** Progressive Computer Productions, 23814 Michigan Ave., Ste 237, Dearborn MI 48124. 313-425-9276.

NOVEMBER 27

IL - GLEN ELLYN — Computer Central. **LOCATION:** College of DuPage, Physical Education Bldg. Main Arena, Park Blvd. & College Rd. **HOURS:** 9:30am-3pm. **ADMISSION:** Adults \$6, 8-12 \$2, under 8 free. \$1 off reg. adult admission w/this ad. **FEATURES:** AC - C - FP. **CONTACT:** Computer Central, Jay B. Robinson, 708-940-7547.

IL - WHEATON — Winterfest. **SPONSOR:** GMRS of Illinois, Inc. **LOCATION:** DuPage County Fairgrounds. **HOURS:** 8am-1pm. **ADMISSION:** \$4 adv., \$5 door. **DEALER INFO:** Setup 6am. Tables \$10 adv., \$12 door. **CONTACT:** GMRS, 2077 W. Roosevelt Rd., Wheaton IL 60187. 708-690-1492.

MI - FLINT — Computer Trade Show. **SPONSOR:** 5 Star Productions. **LOCATION:** Flint Holiday Inn, Gateway Centre, US-23 at Hill Rd. Exit 2 miles S of I-69. **HOURS:** 10am-5pm. **ADMISSION:** \$4, \$3 w/this ad. **FEATURES:** AC - C - CB - DP - F/R. **CONTACT:** Five Star Productions, 810-768-6058 (pager).

MI - SOUTHFIELD — Michigan Computer Festival. **SPONSOR:** Computer Support Services. **LOCATION:** Southfield Pavilion, 26000 Evergreen Rd. **HOURS:** 10am-4pm. **ADMISSION:** \$4 seniors, \$3 students, under 12 free. **FEATURES:** CB - DP - F/R - S.

DEALER INFO: Setup 7:30am-9:45am. 8' tables draped & covered. 1-4 tables \$50 ea., 5+ tables \$40 ea. **CONTACT:** Computer Support Services, POB 1350, Taylor MI 48180. 313-295-2237.

MI - SOUTHGATE — Computer Trade Show. **LOCATION:** Southgate Civic Center, 14700 Dix-Toledo Rd., between Northline & Eureka. **HOURS:** 10am-4pm. **ADMISSION:** Adults \$4; Seniors & students w/ID \$3; under 12 free w/adult. **FEATURES:** C - DP. **CONTACT:** Computers & You, 313-283-1754.

DECEMBER 3

IN - INDIANAPOLIS — Indianapolis Computer Fair. **LOCATION:** Quality Inn East, 35th St. & Shadeland Ave., near Pendleton Pike. **HOURS:** 10am-3pm. **ADMISSION:** \$4. **FEATURES:** C - DP. **CONTACT:** Ben Yanto, AGI Computer Fairs.*

MI - ROSEVILLE — International Canadian/American Mega-Fest Show. **SPONSOR:** E.S.P.S. Corp. **LOCATION:** Days Inn Hotel, 31960 Little Mack. I-94 to Gratiot, go to Masonic, make right, 1/4 mile on right. **HOURS:** 10am-4pm. **ADMISSION:** \$4. **FEATURES:** C - CB - H. **DEALER INFO:** Setup 8am-9:45am. **CONTACT:** John or Sabrina, Bus: 313-884-7690/FAX.

OH - NORTH OLMSSTED — Fall Hamfest. **SPONSOR:** North Coast ARC. **LOCATION:** Saint Clarence Church, 30106 Lorain Rd. **HOURS:** 8am-2pm. **ADMISSION:** \$3 adv., \$4 door. **TALK-IN:** 145.29, 224.76. **DEALER INFO:** 6' table \$8, additional tables \$6. **CONTACT:** Dan Sarama, KB8A, 216-267-5083 or send SASE to: 15591 Rademaker Blvd., Brook Park OH 44142.

DECEMBER 4

MI - GRAND RAPIDS — Computer Trade Show. **LOCATION:** Holiday Inn Crown Plaza, 5700 28th St. S.E., at I-96 Exit #43 (East). **HOURS:** 10am-4pm. **ADMISSION:** Adults \$4; Seniors & students w/ID \$3; under 12 free w/adult. **FEATURES:** C - DP. **CONTACT:** Computers & You, 313-283-1754.

MI - HAZEL PARK — 29th Annual Swap & Shop. **SPONSOR:** Hazel Park ARC. **LOCATION:** Hazel Park High School, 23400 Hughes St. **HOURS:** 8am-2pm. **ADMISSION:** \$4. **TALK-IN:** 146.640. **FEATURES:** DP - FP. **DEALER INFO:** Tables \$13, reservation must be received with check. **CONTACT:** HPARC, Box 368, Hazel Park MI 48030.

MI - TAYLOR — International Canadian/American Mega-Fest Show. **SPONSOR:** E.S.P.S. Corp. **LOCATION:** Holiday Inn, 20777 Eureka Rd. I-75 to Eureka Rd. on E side of Fwy. **HOURS:** 10am-4pm. **ADMISSION:** \$4. **FEATURES:** C - CB - H. **DEALER INFO:** Setup 8am-9:45am. **CONTACT:** John or Sabrina, Bus: 313-884-7690/FAX.

OH - CANTON — Canton Computer Festival. **SPONSOR:** Computer Support Services. **LOCATION:** Canton Memorial Civic Center, 1101 Market Ave. N. **HOURS:** 10am-4pm. **ADMISSION:** \$4, seniors/students \$3, under 12 free. **FEATURES:** C - DP - F/R. **DEALER INFO:** 9,000 sq. ft. open exhibit space. 8' table draped & covered, 1-4 tables \$35 ea., 5+ \$30 Ea. Setup 7:30am-9:45am. **CONTACT:** Computer Support Services, POB 1350, Taylor MI 48180. 313-295-2237.

DECEMBER 10

IL - JACKSONVILLE — Central Illinois Winter Superfest. **SPONSOR:** Jacksonville ARS, Illinois Valley ARC, Central Area ARS. **LOCATION:** Turner Jr. High School, 664 S. Lincoln Ave. **ADMISSION:** \$3, or 2 for \$5 at the door. **TALK-IN:** 146.775 Rpt., 146.52 Simplex. **FEATURES:** CB - DP - EX - FM. **CONTACT:** Tim FB9FB1, 217-245-2061 or Rich, KB9IXO, 217-245-0305, 721 E. State St., Jacksonville IL 62650.

MN - FARIBAULT — Handi-Ham Winter Hamfest. **LOCATION:** Eagles Club. **TALK-IN:** 19/79. **FEATURES:** FM - F/R. **CONTACT:** Don Franz, W0FIT, 1114 Frank Ave., Albert Lea MN 56007

DECEMBER 11

IN - GREENFIELD — 10th Annual Greenfield Hamfest. **SPONSOR:** Hancock ARC. **LOCATION:** Hancock County Fairgrounds. **HOURS:** 8am-2. **ADMISSION:** \$5, under 12 free. **FEATURES:** DP - FM. **DEALER INFO:** Commercial Building spaces \$20 ea., flea market space with table \$12.50 ea. **CONTACT:** Send SASE to: Keith Dalrymple, POB 7033, Greenfield IN 46140.

OH - CLEVELAND — Computer Mania & Auction. **SPONSOR:** National Computer Exposition. **LOCATION:** Holiday Inn/Strongsville, 15471 Royalton Rd. at I-71 Exit 231A. **HOURS:** 10am-4pm. **ADMISSION:** \$1 off w/ad, under 12 free. **FEATURES:** FP. **DEALER INFO:** Setup 8am-10am. Sellouts are common, early booking advised. **CONTACT:** Joe Bowen, 216-442-1776 or Ronald Nelson, FAX: 216-292-7746. National Expo's, Inc., 30799 Pinetree Rd. #230, Cleveland OH 44124.

Continued on page 145

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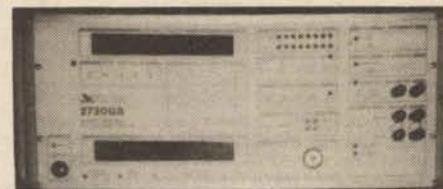
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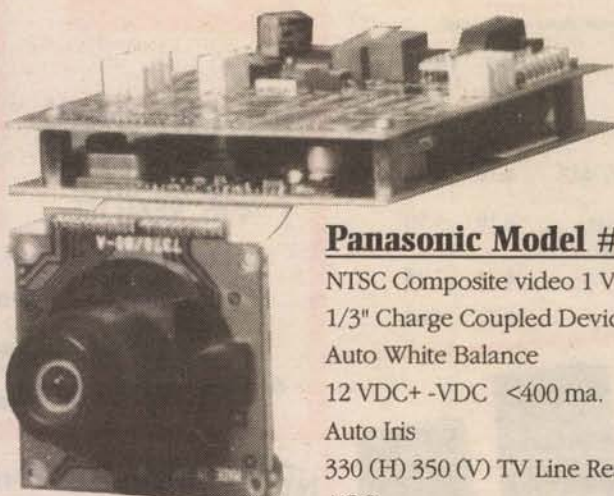
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74LS33	74LS454	1.09	4013	30		
74LS37	74LS455	1.09	4014	69		
74LS38	74LS455	1.09	4015	69		
74LS39	74LS455	1.09	4016	69		
74LS40	74LS455	1.09	4017	49		
74LS41	74LS455	1.09	4018	59		
74LS42	74LS455	1.09	4019	49		
74LS43	74LS455	1.09	4020	69		
74LS44	74LS455	1.09	4021	69		
74LS45	74LS455	1.09	4022	49		
74LS46	74LS455	1.09	4023	49		
74LS47	74LS455	1.09	4024	59		
74LS48	74LS455	1.09	4025	59		
74LS49	74LS455	1.09	4026	59		
74LS50	74LS455	1.09	4027	49		
74LS51	74LS455	1.09	4028	49		
74LS52	74LS455	1.09	4029	49		
74LS53	74LS455	1.09	4030	49		
74LS54	74LS455	1.09	4031	49		
74LS55	74LS455	1.09	4032	139		
74LS56	74LS455	1.09	4033	119		
74LS57	74LS455	1.09	4034	119		
74LS58	74LS455	1.09	4035	119		
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74LS60	74LS455	1.09	4037	119		
74LS61	74LS455	1.09	4038	119		
74LS62	74LS455	1.09	4039	119		
74LS63	74LS455	1.09	4040	119		
74LS64	74LS455	1.09	4041	119		
74LS65	74LS455	1.09	4042	69		
74LS66	74LS455	1.09	4043	69		
74LS67	74LS455	1.09	4044	69		
74LS68	74LS455	1.09	4045	129		
74LS69	74LS455	1.09	4046	129		
74LS70	74LS455	1.09	4047	79		
74LS71	74LS455	1.09	4048	79		
74LS72	74LS455	1.09	4049	79		
74LS73	74LS455	1.09	4050	79		
74LS74	74LS455	1.09	4051	79		
74LS75	74LS455	1.09	4052	79		
74LS76	74LS455	1.09	4053	79		
74LS77	74LS455	1.09	4054	79		
74LS78	74LS455	1.09	4055	79		
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74LS80	74LS455	1.09	4057	79		
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74LS83	74LS455	1.09	4060	79		
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74LS98	74LS455	1.09	4075	79		
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74LS102	74LS455	1.09	4079	79		
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74LS121	74LS455	1.09	4098	79		
74LS122	74LS455	1.09	4099	79		
74LS123	74LS455	1.09	4100	79		
74LS124	74LS455	1.09	4101	79		
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74LS126	74LS455	1.09	4103	79		
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74LS180	74LS455	1.09	4157	79		
74LS181	74LS455	1.09	4158	79		
74LS182	74LS455	1.09	4159	79		
74LS183	74LS455	1.09	4160	79		
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74LS185	74LS455	1.09	4162	79		
74LS186	74LS455	1.09	4163	79		
74LS187	74LS455	1.09	4164	79		
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74LS189	74LS455	1.09	4166	79		
74LS190	74LS455	1.09	4167	79		
74LS191	74LS455	1.09	4168	79		
74LS192	74LS455	1.09	4169	79		
74LS193	74LS455	1.09	4170	79		
74LS194	74LS455	1.09	4171	79		
74LS195	74LS455	1.09	4172	79		
74LS196	74LS455	1.09	4173	79		
74LS197	74LS455	1.09	4174	79		
74LS198	74LS455	1.09	4175	79		
74LS199	74LS455	1.09	4176	79		
74LS200	74LS455	1.09	4177	79		
74LS201	74LS455	1.09	4178	79		
74LS202	74LS455	1.09	4179	79		
74LS203	74LS455	1.09	4180	79		
74LS204	74LS455	1.09	4181	79		
74LS205	74LS455	1.09	4182	79		
74LS206	74LS455	1.09	4183	79		
74LS207	74LS455	1.09	4184	79		
74LS208	74LS455	1.09	4185	79		
74LS209	74LS455	1.09	4186	79		
74LS210	74LS455	1.09	4187	79		
74LS211	74LS455	1.09	4188	79		
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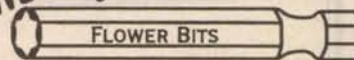
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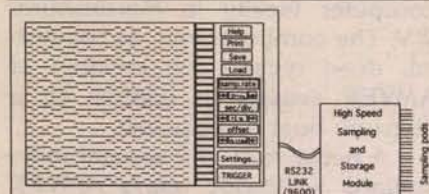
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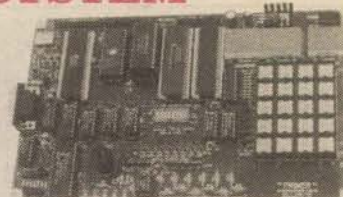
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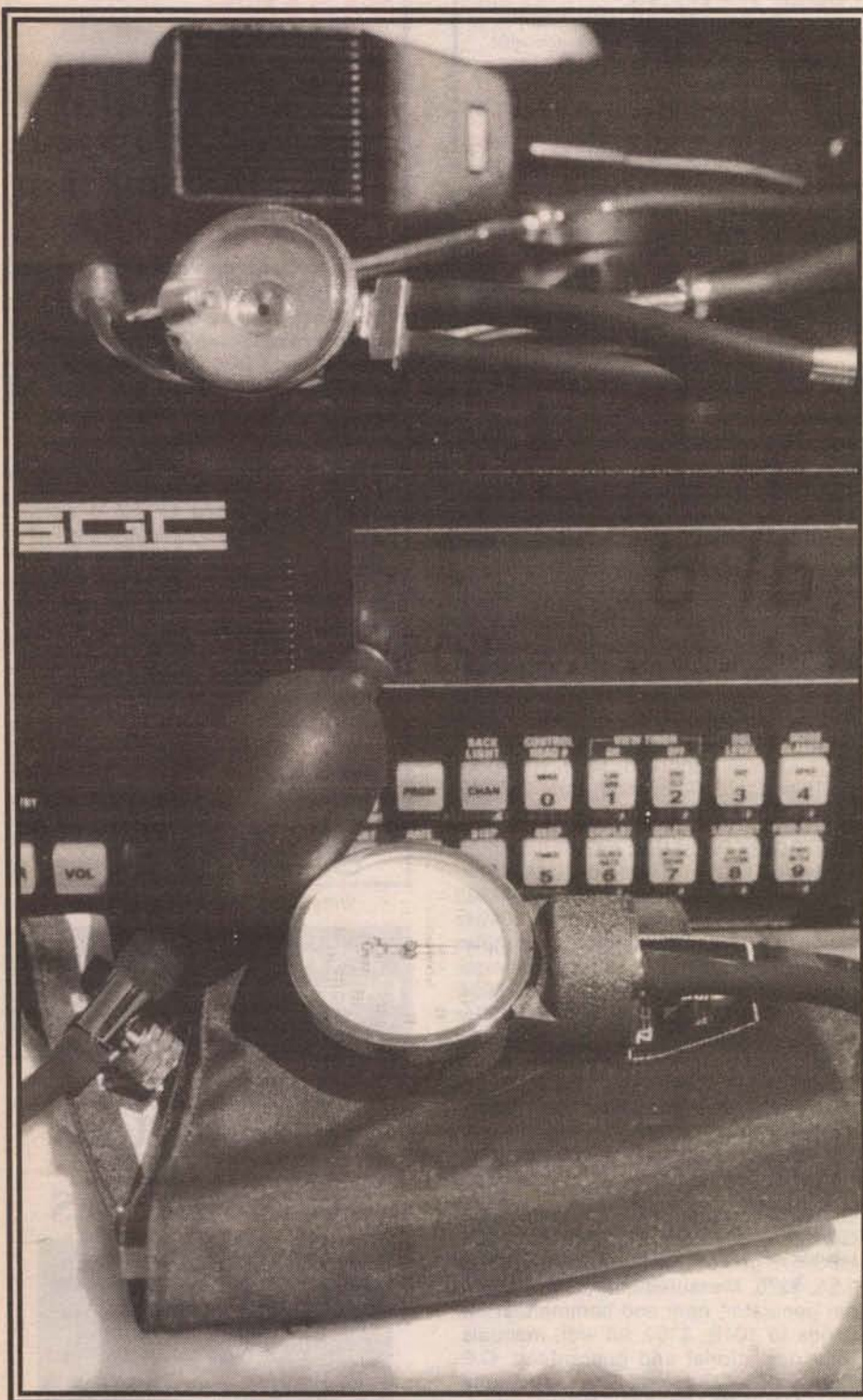
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RADIO DOCTORS GIVE FREE ADVICE ON MARINE H.F. SSB



As you tune around the hundreds of marine SSB channels, you come across one duplex frequency pair that sounds like it is straight from the TV series "Rescue 911."

channels, assigned a frequency pair by their ITU channel designators, are monitored by the following United States Coast Guard communications facilities:

- Miami, call sign NMA, Channel 601 primary, 24 hours
- San Francisco, call sign NMC, all channels, 24 hours
- Boston, call sign NMF, all channels
- New Orleans, call sign NMG, all channels
- Portsmouth, call sign NMN, all channels
- Honolulu, call sign NMO, all channels
- Kodiak, call sign NOJ, Channel 601 primary
- Guam, call sign NRV, all channels

WHAT, NO 2182 KHz?

These U.S. Coast Guard ITU (International Telecommunications Union) duplex (one for transmit, one for receive) channels are high enough in frequency that the ionosphere will refract the skywave signals over thousands of miles.

Channel 424 and Channel 601 are best for nighttime use. Channel 816, Channel 1205, and Channel 1625 are best for daytime use. The international distress and national calling frequency 2182 KHz, simplex, is so low in frequency that daytime ionospheric absorption renders the frequency almost useless for any range beyond 50 miles. You could probably do better on marine VHF Channel 16.

At nighttime, 2182 KHz is hampered by static from lightning thousands of miles away, so propagation of this short-range frequency to any Coast Guard shore facility would only be limited to 500 miles at its sporadic best. You could get lucky and find a passing cruise ship on 2182 KHz, but 2182

KHz would not necessarily be the very best frequency to shout Mayday on for someone over 500 miles away.

The U.S. Coast Guard AMVER duplex channels are part of a worldwide network of the Automated Mutual-Assistance Vessel Rescue system, which began in 1958 as a computerized search and rescue tool for merchant ships in the North Atlantic ocean. Today, AMVER is the only worldwide safety network, safeguarding ships for more than 134 nations, in every ocean of the world. This service is as much a part of pleasure sailing boats as it is for commercial ships. AMVER reflects the essence of that bond between any type of vessel out on the high seas.

AMVER participation is free, voluntary, and available to ships of all nations, making it a cost-effective and efficient search and rescue tool. AMVER is fully endorsed by the International Maritime Organization (IMO) and is available to the world's cruise and shipping communities, as well as all pleasure yachts.

Every day, more than 2,600 vessels worldwide participate in the AMVER safety network. A computer at AMVER headquarters on Governors Island in New York plots the voyages of more than 15,000 ships. Significant voyage information such as time of departure, destination, turn points, radio call sign, MEDICAL PERSONNEL ONBOARD, and other relevant data are transmitted to the AMVER computer facility in Martinsburg, WV. The computer can, as requested, dead reckon the location of AMVER vessels in relation to a pleasure boat distress call.

A network of 130 coastal radio stations worldwide relays AMVER position reports from participants at no cost. All AMVER reports from

by Gordon West EMT-P

"Give your patient an eight liter flow of oxygen by the face mask. Place a sterile dressing over the avulsed wound. When the dressing soaks through, don't remove it — just put another sterile dressing over the first one and so on," instructs the radio operator relaying the U.S. Coast Guard's flight surgeon's instructions.

"But there is something sticking out of the flesh," is the other side of the conversation you can hear by pushing the "TX" offset on your marine SSB transceiver.

"Just leave it alone — get the dressing around it and stop the

bleeding now," instructs the Coast Guard radio officer.

This is not a test. This is not an exercise. This is the real thing, carried out on almost a daily basis over marine single sideband AMVER Coast Guard frequencies. You are listening to real-life drama that is taking place somewhere out on the high seas, thousands of miles away from any medical facility. The frequencies are duplex — the ship frequency is separated several hundred kilohertz below the coast transmit frequency. Marine single sideband transceivers are all factory pre-programmed for instant dial-up of the U.S. Coast Guard AMVER safety liaison channels shown in Table 1.

These marine SSB duplex

TABLE 1

CHAN. 424	CHAN. 601	CHAN. 816	CHAN. 1205	CHAN. 1625
4426 KHz	6501 KHz	8764 KHz	13089 KHz	17314 KHz
RX	RX	RX	RX	RX
4134 KHz	6200 KHz	8240 KHz	12242 KHz	16432 KHz
TX	TX	TX	TX	TX



Marine SSB long range radios can reach the Coast Guard Doctor quick!

ty over other radio calls on frequency. You should get an immediate response.

If you can't get directly through to the U.S. Coast Guard on their AMVER ITU channels, switch frequencies for the GORDON WEST BEST BET to reach someone on shore to alert the Coast Guard — AT&T high seas marine operators.

The AT&T public correspondence channels are vigorously monitored for incoming traffic. After all, their revenue depends on getting every single call from all ship stations coming in on their frequencies.

"Here at station KMI serving the Pacific, we can patch you into the U.S. Coast Guard within seconds of receiving your call for help," comments John Schuster, manager of the KMI high seas radiotelephone station in Oakland. "When we receive a declared emergency call, we dial

adds the Coast Guard.

AMVER CALLING PROCEDURE

AMVER Channel 816 and Channel 1205 are your best bet for reaching out thousands of miles to one of the U.S. Coast Guard monitoring facilities. Say the words, "Calling the Coast Guard on AMVER Channel —," for 45 solid seconds, interspersing your vessel name, FCC call letters, and your approximate location. Speak directly into the microphone held less than one inch from your mouth, and repeat your call continuously for 45 seconds, and then listen for 30 seconds. Repeat this

sequence three or four times to attract the attention of the U.S. Coast Guard monitoring stations.

If it's a life-threatening emergency, punctuate your call with the words "Mayday, Mayday, Mayday." This puts your call as the highest priority.

Regardless of the marine SSB you have purchased, if it is fully synthesized (as opposed to crystal-controlled), it will have these AMVER ITU channels permanently stored in memory and completely safe from accidental erasure.

commercial boats are protected and are used exclusively for humanitarian purposes. It is available only to recognized search and rescue agencies around the world.

**U.S. Coast Guard
AMVER Safety Network
Building 110
Governors Island,
New York, NY 10004
PHONE (212) 668-7764
FAX (212) 668-768.**

YOUR DOCTOR ON H.F. SSB

Onboard medical emergencies are a daily occurrence over the AMVER SSB long-range channels. Popular U.S.-sold marine SSB transceivers for pleasure boats all have these channels preprogrammed into a permanent ITU memory bank:

- Furuno
- Harris
- Hull
- ICOM America

- Kenwood
- Radio Holland
- Raytheon
- SEA
- SGC

Here in the United States, all U.S. Coast Guard communication stations (COMMSTAS) electronically scan the AMVER frequencies for incoming distress or emergency medical traffic coming from pleasure and commercial vessels.

"We electronically scan these channels, so any call up to our radio station must be a relatively long one in order for our sets to lock on," comments the U.S. Coast Guard communications facility, NMC. "Just a quick call to any Coast Guard facility might be missed in all of the other traffic that we are simultaneously listening to,"

Emergency medical personnel are as close as your SSB microphone.



marine telephone service and the U.S. Coast Guard, they are comparable in every sense. Once you make contact, they will hear you, and you will hear them extremely well no matter where in the world you are, up to 8,000 miles away from the U.S. coast line.

For onboard medical emergencies, the U.S. Coast Guard may elect for the victim to be evacuated by a nearby commercial or military vessel via their AMVER reported position. During the 1969 trans-Pacific yacht race, a mariner aboard "Mahia" was hit in the head with a spinnaker pole and was bleeding profusely and was paralyzed. Via the U.S. Coast Guard AMVER system, a U.S. Navy submarine surfaces out of the depths below, sends over a corpsman, and the patient gets a fast underwater ride to a Pearl Harbor hospital. Unbelievable, but routine for the AMVER system.

But sometimes you are out there with no nearby help. This is where the U.S. Coast Guard brings the flight surgeon on line to discuss emergency medical measures.

Do you have an emergency medical kit onboard? Who is qualified to follow the instructions to use what is inside? You will also be asked a LENGTHY work-up on the injured person onboard. No doctor's advice is given out over the airwaves until EVERYTHING is known about the patient and his or her injury.

"If someone in Banderas Bay is bitten by a sea snake, we need to know everything about that sea snake, too," adds a Coast Guard medical corpsman out of San Diego. "Color, length, description of its mouth, special markings — we need as much information as possible before attempting to diagnose and treat an emergency over radio waves," adds the corpsman.

And the U.S. Coast Guard also has back-up medical advice from the only hospital in the world that gives out doctor's "advice" to any mariner in trouble: CIRM Roma Hospital in Italy. CIRM Roma can be contacted through a local rescue agency or direct via satellite communications in rare cases where they might have the answer to a mysterious illness onboard. This hospital can communicate in all languages, and it takes about 12 hours to get an official opinion from a CIRM Roma doctor. With the U.S. Coast Guard flight surgeon, they can many times come up with advice in less than a half hour.

PRE-EMERGENCY PREPARATION

1) Is your marine SSB trans-

ceiver properly licensed with the Federal Communications Commission and fully functional on all ITU channels? You can run radio checks with the high seas marine operator stations KMI, WOO, and WOM. Don't use AMVER frequencies for radio checks EVER.

2) Free high seas marine SSB frequency guide. Send a self-addressed large envelope with five first-class stamps inside the envelope to Gordon West, ATTN: AT&T Frequency Guide, 2414 College Drive, Costa Mesa, CA 92626.

3) Listen in on the following ITU channels, and know how to dial them up quickly:

- Channel 424
- Channel 601
- Channel 816
- Channel 1205
- Channel 1625

If the channel is clear, check both the receive and transmit frequencies to insure they agree with the AMVER frequencies listed in this article.

4) Before sailing, take an emergency medical technician course, or other approved medical emergency at sea seminar to develop a medical kit and paperwork for the collection of necessary information for the U.S. Coast Guard's flight surgeon. Work with your medical emergency instructor to develop a medical kit that will serve the emergency needs of everyone onboard.

5) Periodically, run through a medical emergency exercise, and use the AT&T high seas marine operator as a radio check to assure you of being able to get back to shore with a radio call to reach the U.S. Coast Guard flight surgeon.

6) Join AMVER. Write or call them for their information pack, and give them a donation for their newsletters. They could save your life. While you won't be checking into the AMVER system on a daily basis, get to know their service in case you need to find some medical help near you out there on all that water. And if there's nobody close by, your long-range SSB transceiver can get the doctor on the line in just a matter of minutes. **NV**

Gordon West is a registered emergency medical technician with charter membership to the National Registry of Emergency Medical Technicians, and holds numerous FCC radio licenses and runs Gordon West Radio School for both amateur radio training, as well as commercial radiotelephone operator license instruction.

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HP 1725A 400MHZ oscilloscope \$500, HP 8413 phase gain indicator \$100, HP 3575A gain phase meter \$675, HP 6131B digital voltage source \$175, HP 6201 power supply \$80, HP 580A digital analog converter \$100, Fluke 8500A digital multimeter \$65, Systron Donner counter/timer 6150 \$75, Fluke 1953AE counter timer \$250, Fluke 8000 digital multimeter \$60, Tek 7B71 \$100, Tek P6451 data acquisition probe \$45, Keithley 169 multimeter, 177 microvolt DMM \$80, GRD 2300 systems development systems call, Preston GMAD-1A analog to digital conversion system \$100, Elgar 441, 443, Series 400 fixed frequency oscillator \$50, freq. multiplier 45Hz-10KHz \$100, H-H Scott random noise generator \$50, Phillips chart recorder PM8236 \$125, Tek 8540 integration unit \$100, HP 10269B, ageneral purpose probe interface \$50, HP 2912A feed scanner \$75, HP 85 \$100, HP 3453A digital stimulator response call. 714-827-7345.

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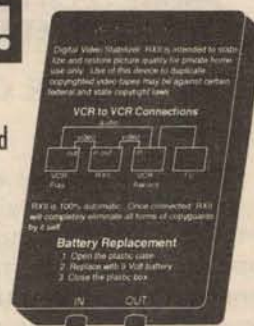
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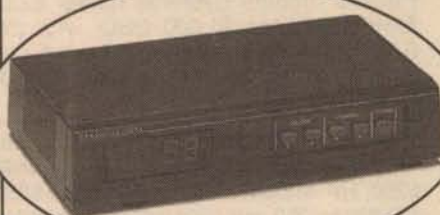
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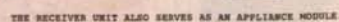
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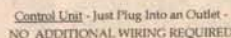
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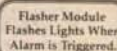
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An Easy-to-Build, Inexpensive Video Game

by Mark Emery Bolles

Like all other aspects of electronic technology, video games have progressed rapidly over the last few years. The advance of technology has been so quick that now, in these days of Kung Fu fighters and space aliens, we have forgotten that it wasn't that many years ago that "video game" meant some sort of paddle and ball affair on the TV screen. I can remember — and it wasn't that long ago — when kids would feed many quarters into machines at the arcade so that they could play Pong, the game this article describes how to build.

This project will show you how to build a unit that displays on any TV set, and allows you to play four different paddle and ball-type games. I will admit that it seems rather tame by today's standards, but if you can't afford that \$200.00 Nintendo, or if your eight-year-old keeps buying those kind of movies on late night pay-per-view, this may be just what the doctor ordered. My kids love it, and even I have used up a few hours, ah, researching its utility for the purposes of this article (no need to thank me; it's all in the name of science).

The unit has enough options — ball speed, paddle size, etc. — that the game can be played by very young children, yet it can also be quite challenging, regardless of age or experience with more sophisticated game systems.

In the deluxe version, what you will end up with is a unit that plays four different games: Pong, Hockey, Squash, and Practice (single player mode). Switches allow you to select paddle size, ball speed, and rebound angle, as well as a "Pause serve" function. Outputs include standard NTSC (for newer TVs with a video input), and RF out (for display on Channels 3 or 4). The unit can be powered from a plug-in wall transformer or a 9-volt battery.

If you have a newer television, chances are that it has an NTSC signal input, as do most VCRs. For these, the game unit has an NTSC video signal output that can be plugged straight into the television for display. For those of you whose televisions do not have a video input jack, the unit provides an RF output so that any television can tune in

the signal with the television's channel selector. This unit uses an extremely simple, yet surprisingly effective, RF video modulator circuit that will display the video data on Channel 3 or 4.

The cost of this project can vary widely, depending on the approach you take. For the purposes of this article, I

3-8500-1. This VLSI chip does practically all the work in this circuit, including generating the sync signals for NTSC output. Very few support components are required to make this chip go; basically, it just needs some external switches, a couple of pots for paddle control, and a 2 MHz clock.

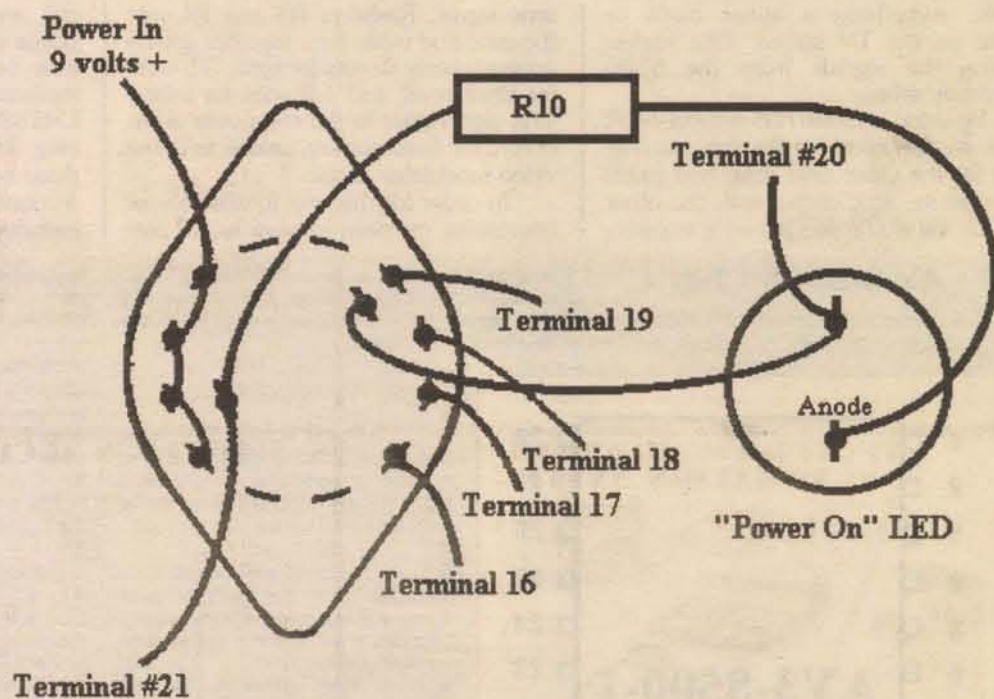


FIGURE 2 — Wiring of Selector Switch and LED

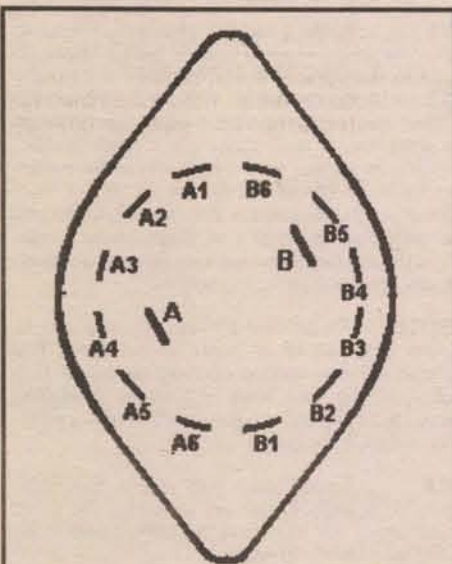


FIGURE 1
6-Position Rotary Switch
R.S. #275-1386
Pin Assignments
(from rear)

built a deluxe prototype using a lot of brand new parts from Radio Shack (not the cheapest way to go); this deluxe version cost about \$45.00. But with a well-stocked parts bin and a little careful shopping, you can easily build this project for \$10.00 or less.

The Circuit

Look at the schematic. The heart of the unit is the General Instruments AY-

The clock signal is generated by a standard 2 MHz crystal, driven and stabilized by a CMOS 4011 NAND gate, and wired as an inverter (I chose the 4011 because a normal inverter chip, such as the 4049, draws much more current). This clock signal is fed to the 8500's clock input.

The 8500 has separate outputs for ball, paddles, score/playing field, and sync (see 8500 sidebar). As used here, the game does not generate any gray

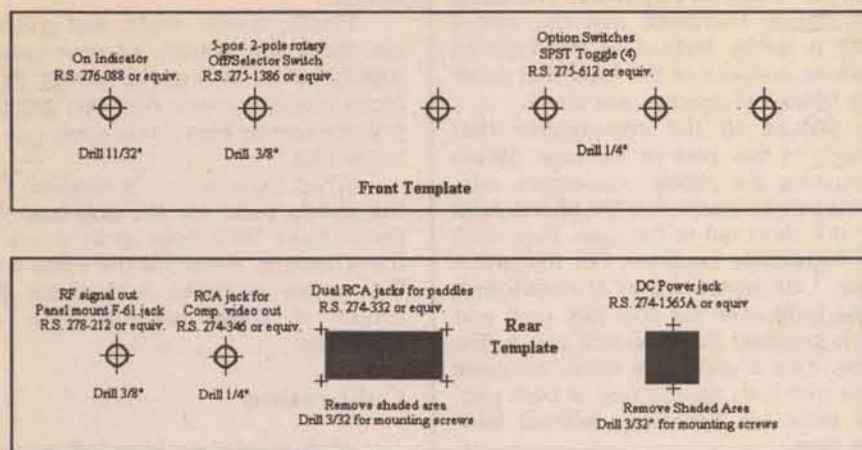


FIGURE 3 — Drilling Templates

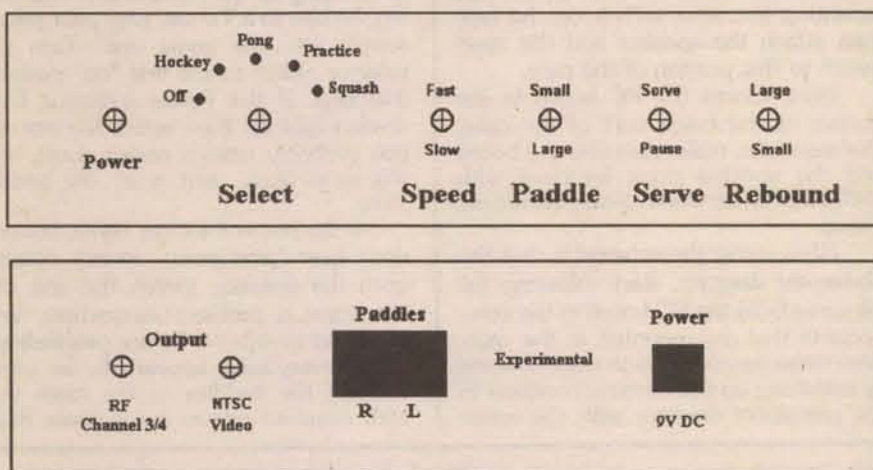


FIGURE 4 — Case Labels

— and as you can see from the schematic, it doesn't get much simpler than this.

Three inverters from a 74LS04 are used to generate the carrier frequency for our RF signal. Since we are using an odd number of inverters in a closed loop, the circuit is inherently unstable, and has no choice but to oscillate. Ungoverned, this circuit would oscillate at a frequency that is dictated by the chip's maximum speed, as defined by the propagation delay. With the 74LS04, the databooks say that this can be as fast as 3 nanoseconds per gate, or 111 MHz for this three gate loop.

But the databooks also say that the primary variable in the chip's propagation delay time is the capacitive loading on the inverter's pins. This means that we can control the oscillation frequency by varying the capacitive loading, and this is the function of variable capacitor C3.

The picture component of Channel 3 is broadcast at 61.25 MHz; Channel 4 is at 67.25 MHz. Through empirical experimentation (that means fiddling around with it for a long time), I determined that C3 should be adjustable from about 20 to 30 picofarads to generate the proper frequencies for Channels 3 or 4.

The question then becomes this: Where the heck do you find a trimmer capacitor with the relatively specialized range of 20 to 30 picofarads? The answer is simple: you probably can't. This became a bit of a problem, because the best I could do was find a trimmer capacitor that went from 7 to 100 pF; and since a change of 1 or 2 pF meant a variation of almost 1 MHz, this made

the circuit extremely difficult to tune accurately. The solution to this particular problem is the presence of fixed capacitor C4, which narrows the range of C3 so it isn't so twitchy to tune. See the sidebar for an explanation of this technique.

Once we have our 61.25 or 67.25 MHz carrier frequency, we add in the composite video signal through trimmer pot R7, which defines the contrast level. The final gate from the 74LS04 stabilizes the combined signals; this RF output then goes to a female F-61 connector. A standard TV cable can be connected between this output and the television's 75-ohm cable input for display.

Note that this chip must be from the LS family. HC, TTL, ALS, or whatever will probably not work. Since the rest of the circuit operates from 9 volts, but the LS needs 5 volts for its power supply, a 78L05 regulator is added to the circuit. This gives U3 a nice stable power supply, which happens to be another one of the variables that defines the oscillation frequency of the '04. Stability in the power supply to this chip means stability in the picture displayed on the television.

Sound effects are generated by the 8500, and the signal is available at pin 3. Ideally, we would add the sound to the RF modulator, but this would complicate the circuit tremendously. The sound portion of a TV signal is broadcast on a carrier that is 4.5 MHz higher than the picture signal, and unlike the amplitude-modulated picture signal, the sound is frequency modulated. Since the design parameters for this unit were to build it as simply and cheaply as possible, I designed it so that the sound sig-

Redefining Range

When designing circuits, it is very easy to implement the theory we have been taught over the years; usually, a circuit's requirements for the values of discrete components can be ascertained with some simple math, and confirmed through experimentation.

But theory is one thing, and the real world is something else. It is not uncommon for a circuit to require a component with certain theoretical values that just doesn't exist in the real world, is difficult to find, or is economically unfeasible to use once found.

This project is a case in point. I determined that the video modulator section required a variable capacitor with a range of 20 pF to 30 pF; but no such animal could be found. In fact, the best I could do was a single-turn trimmer that varied from 7 to 100 pF.

Again, theory would say that this is not a problem; although the range of the trimmer is much greater than required, as long as it can deliver the capacitance values in the range required (20-30 pF), we should be okay, right? But once again, reality rears its ugly head. In order for the circuit to work, it is necessary to adjust the capacitor to a tolerance of plus or minus 1 pF. Over a range of 93 pF, that means that we have to be able to adjust the trimmer to almost 1% of its range, which is extremely difficult to do.

We can state the difficulty another way: the screwdriver I use to turn the trimmer's adjustment screw is 1/8" in diameter (.125"), that means that the distance the barrel of the screwdriver travels in one full turn is .125 * pi, or .392". To get a 1% adjustment, we need to be able to adjust the trimmer to within four thousandths of an inch travel — which, though not impossible, is extremely difficult. We need to find a method that will make adjustment of the trimmer easier and less "twitchy."

You may recall from basic electronic theory that when you put two resistors in series, you add their resistances together; so two 100-ohm resistors in series will give a resistance of 100 + 100 = 200 ohm.

If those same resistors are hooked up in parallel, then the resistance is obtained with the formula known as the *product over the sum*. Mathematically, it is expressed as:

$$\frac{R1 * R2}{R1 + R2} = \text{Total Resistance}$$

so, substituting the values for our two resistors, we find that

$$\frac{100 * 100}{100 + 100} = \frac{10000}{200} = 50 \text{ ohms}$$

This brings up Rule #1: *Two identical resistors in parallel will have a combined resistance that is exactly half the value of each resistor.* So these two 100-ohm resistors have a combined resistance of 50 ohm; two 1000-ohm resistors will yield a resistance of 500 ohm; two 10-megohm resis-

tors will yield 5 megohm.

Let's take an example where the resistors are of different values; say, 1000 and 50:

$$\frac{1000 * 50}{1000 + 50} = \frac{50000}{1050} = 47.6 \text{ ohms}$$

This brings up Rule #2: *The combined resistance of resistors in parallel will always be less than the value of the smallest resistor.* As you can see from the example above, the total resistance of the two resistors in parallel (47.6 ohm) is less than the 50-ohm resistor.

Finally, just for completeness, the formula for more than two resistances in parallel is known as the *inverse of the sum of the inverses*. It looks like this:

$$\frac{1}{\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} + \frac{1}{R4} + \dots + \frac{1}{Rn}}$$

This formula works regardless of the number of resistors, whereas the product over the sum method only works for two.

Multiple capacitances can be computed in the same manner. The only difference is that capacitors in series are equivalent to resistors in parallel, and capacitors in parallel work like resistors in series. So, while two 100-ohm resistors in series will yield 100 + 100 = 200 ohm, two 100 µF capacitors in parallel will yield 100 + 100 = 200 µF. By the same token, two 100 µF capacitors in series would yield 50 µF total capacitance.

This effect can be used to change the range of a trimmer capacitor which, as in our video modulator circuit, has too wide a range. Notice what happens when we combine a trimmer capacitor, variable from 10 pF to 100 pF, in series with fixed capacitors with values of 100 pF, 47 pF, and 22 pF, shown in Table 1.

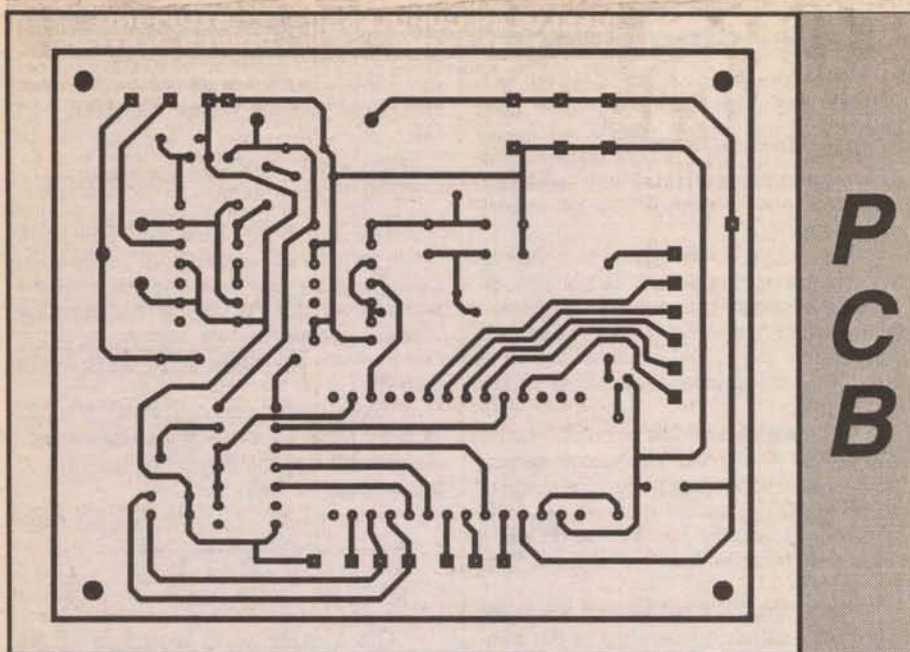
As you can see, by choosing the value of the fixed capacitor carefully, we can adjust the spread of the variable trimmer to anything we want, provided that the range spread is smaller than that of the trimmer. In other words, we can only narrow the trimmer's range. We cannot enlarge it.

If desired, we can then offset the range spread by adding another capacitor in parallel. For example, if we needed a variable capacitance from approximately 50 pF to 70 pF, we could take a 42 pF fixed capacitor, and hook it up in parallel with the above combination of the 10-100 pF trimmer wired in series with a 47 pF fixed capacitor. This would give us a range of 50.2 pF to 73.9 pF.

The only caveat to bear in mind: one is that most fixed capacitors have a tolerance of ±20%, so your theoretical calculations should always be backed up with empirical confirmation. Remember that this same technique works with resistors, too; with a little time and calculation, we can make real world parts conform to our theoretical desires.

Table 1 — 10-100 pF Variable Trimmer Capacitor in Series With:

Trimmer adjusted to:	100 pF	47 pF	22 pF
10	9	8.2	6.8
20	16.6	14	10.4
30	23	18.3	12.7
40	28.5	21.6	14.2
50	33.3	24.2	15.2
60	37.5	26.3	16
70	41	28	16.7
80	44.4	29.6	17.2
90	47.3	30.8	17.6
100	50	31.9	18
Total Range Spread:			
90 pF	41	23.7	11.2



nal is fed to a simple transistor amplifier, and then straight to an 8-ohm speaker housed in the unit's case. Of course, to keep costs down further, the sound circuit could be eliminated altogether.

The paddle controls are simply 1 megohm pots in their own cases. I used standard audio cables and phone jacks to connect the controls to the main unit case; this eliminated having to worry about child-proofing, strain relief, and future repairability.

The rest of the circuit is primarily the switches that allow you to select the various games and options. For the main selector switch, I used a two-pole, six-position (though only five positions are required) rotary switch from Radio Shack. This allowed me to combine the game selector function with the power on/off control. A high-brightness LED, with current-limiting resistor R10, indicates when power is on. A few capacitors are scattered around for power supply decoupling, contributing to circuit stability.

Construction

The FCC considers this a Class 1 device, meaning that it is subject to FCC type approval. As long as you don't interfere with anyone else, you'll probably be fine; but if your next door neighbor starts seeing your Pong game on his TV when Montana is dropping back on fourth down, he might call the FCC, and those guys can be amazingly testy sometimes.

I mention this because you can use any number of methods to build the circuit, but some methods are more prone to generating RF interference than others. To minimize such problems, I would recommend that you build this on a single-sided printed circuit board, for which the artwork is provided, and enclose it in an all-metal case, like the Radio Shack #270-272A. There should be absolutely no interference problems if you go this route.

Prior to etching the board, make sure you have the 2 MHz crystal and capacitor C3, as well as trimmer pot R7. These parts can vary in size, and you should make sure that they match the board properly prior to etching. Make any adjustments to the artwork that variation in these parts may require.

Start by etching and drilling the board using your favorite method; check all traces for opens or shorts. When you are sure you have a good board, start

mounting the components as indicated in the placement diagram (Figure 5). Sockets for the four ICs are desirable, but not required. Solder and test each connection for continuity as you go; care and deliberation at this stage can save you hours of troubleshooting later. Double check the orientation of Q1 and Q2 prior to soldering. Don't forget the jumper wire.

When all components are mounted and soldered in place, cut 24 - 6" lengths of hookup wire, and solder these to each of the terminals identified

on the board in the placement diagram (T1 through T24). Place the board aside for now.

If you don't use the case that I recommend, spend a little time planning how you are going to mount the switches and such. Make paper templates, and make sure that everything is going to fit correctly.

If you do use the case that I have recommended, then you can use the templates provided (Figure 3). The case has two parts: the beige half forms the front and back panels, as well as the bottom; the black half forms the top and sides.

Attach the drilling templates to the case front and back using a light coat of rubber cement. Drill as indicated, and remove the shaded areas with a nibbler, and clean everything up with files. Peel off the drilling templates, and permanently affix the front and back labels (Figure 4) to the case, using the holes

you just drilled for alignment. The labels are slightly oversized; trim the excess with a hobby knife. Use the knife to remove portions of the label that cover the holes and cut-outs you made.

Mount all the components that attach to this part of the case. When mounting the paddle connectors, take extra care to ensure that the phone jacks do not short out to the case; they must be completely insulated. For my prototype, I cut several layers of electrician's tape to fit over the dual jack unit, and then mounted this dual jack unit to the case. Use a continuity tester to make sure that both tip and ring of both paddle jacks are electrically isolated from the case.

In the top (black) part of the case, drill holes to mount the speaker on the left side of the unit; drill some large holes over the cone area to allow the sound to be audible. Drill a hole for mounting the reset switch on the top; then attach the speaker and the reset switch to this portion of the case.

Now, mount the PC board to the bottom of the beige part of the case. Use standoffs; make sure that the board and the speaker don't interfere with each other when the two case halves are joined.

Now, using the schematic and the placement diagram, start soldering the 24 wires from the PC board to the components that are mounted in the case. Wire these components to the PC board by matching up the terminal numbers in the placement diagram with the termi-

switch.

Finally, double, triple, and quadruple check the polarity of your power supply before wiring the power jack. Make absolutely sure that you get the polarity correct before you apply power to the unit.

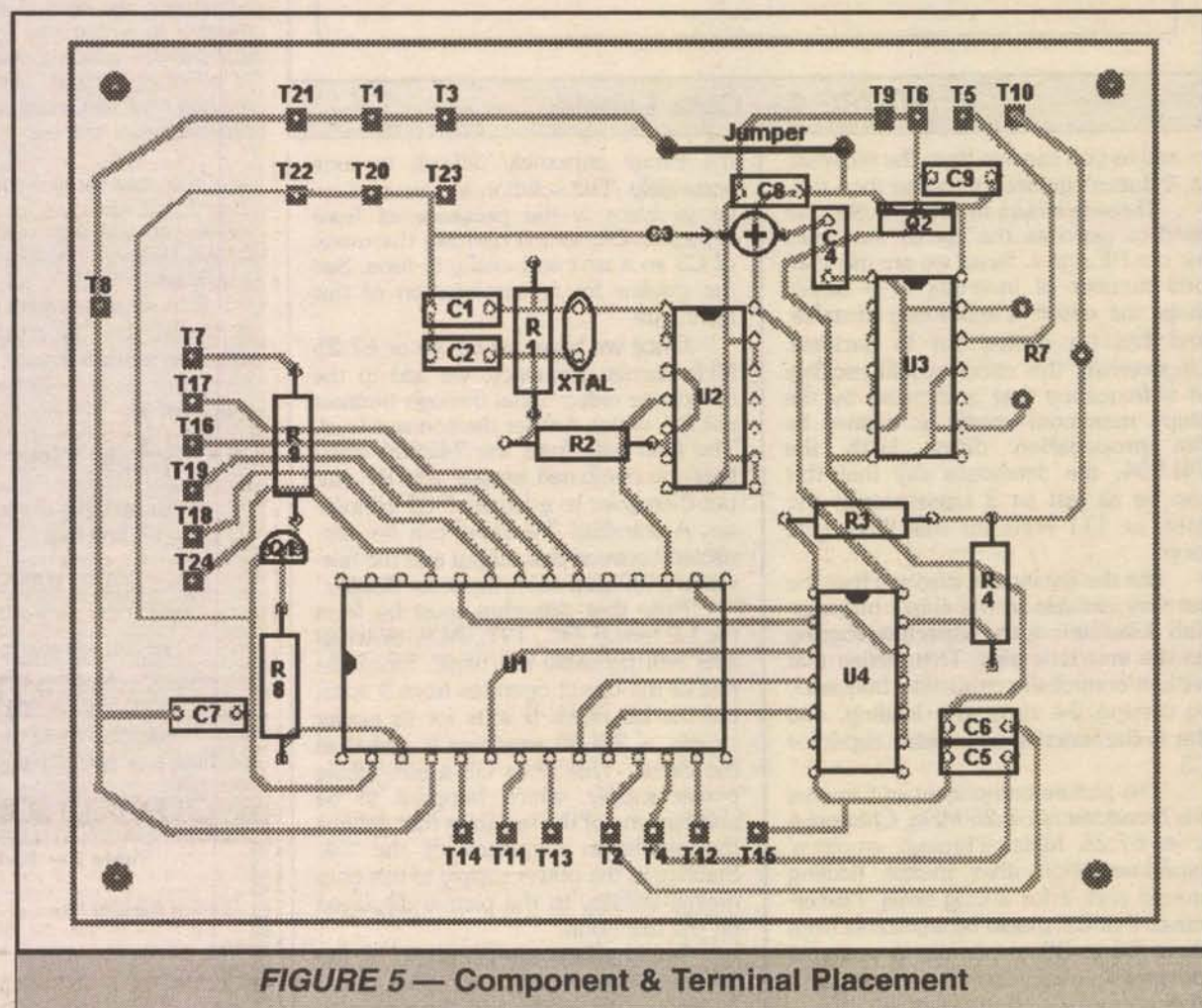
When the main unit is finished, drill the paddle cases for the pots and the phone jacks. Wire them up as shown in the schematic. Assemble the cases with the screws provided, and check the action of these controls with an ohmmeter.

Calibration

When you have soldered all connections, tested each one for continuity and short circuits, and visually inspected your work for solder bridges and other flaws, you are ready for calibration. Prior to hooking up the paddles and connecting the unit to a TV set, plug your power supply into the game unit. Turn the selector switch to the first "on" position (Hockey). If the Power Indicator LED doesn't light up, then switch the unit off; you probably have a power short, and the most likely spot is at the paddle jacks.

If the power indicator lights, but you don't hear "ping pong" sounds coming from the speaker, switch the unit off. You have a problem somewhere, and you need to repair it before proceeding.

If everything appears to be okay, connect the paddles to the main unit with standard phono cords (male RCA



nal numbers in the schematic. Double and triple check each wire; trim the length of the wires so that you have a nice, neat installation. For the connections to the speaker and reset switch, leave some extra length so that after soldering, the two case halves can be comfortably separated without breaking any wires. Refer to Figures 1 and 2 for the best way to wire the rotary selector

plug at each end). Turn the paddle pots to their mid positions; they will disappear from the screen if the pots are rotated to their extremes.

At this point, it would be preferable to test the unit's composite video output, before we try and calibrate the RF output. If your TV has a video input (it'll be a phono jack labeled "Video In," or some such), hook the unit up to the television

through the game unit's composite video output, and make sure the picture is okay. If your TV doesn't have a Video In jack, then check your VCR; it probably does, and you can broadcast the picture to the television through that. If neither of those options are possible, you might see if someone has a video modulator, like the Radio Shack 15-1273, that you can borrow to test this output and make sure that the unit is generating the picture correctly.

If you test the composite video output, but find that the picture is not clear, or the ball, paddles, or playing field is missing, or the picture is rolling and tearing, then you have a bad connection somewhere. Fix it before proceeding. If you don't see the paddles on the screen, turn the paddle pots until the paddles are visible; if that doesn't work, then you have a problem between the 8500 chip and the paddle pots.

Once you have determined that you have a good picture from the composite video output, connect the game unit's RF output to your television's cable input (or the antenna lead screws using a 300-ohm impedance matching transformer). Tune the television to Channel 3 or 4, and turn the sound all the way down.

Adjust the board-mounted trimmer pot R7 to about half-way through its range. Adjust C3 to tune the picture in. This may take a little patience; your screwdriver may change C3's capacitance a little. Keep adjusting until you have a nice clear picture. C3 will not adjust the picture's contrast; right now, all you want to do is get a clear, stable picture with a minimum of interference, although it may be a little pale.

When you have the best possible picture tuned in, adjust R7 so that the picture shows a deep contrast, without any tearing. When you have obtained maximum contrast, you may have to go back and adjust C3 again for a perfect picture. Once that is done, turn the game unit off, and assemble the two parts of the case. Test the picture quality again; make any adjustments that seem necessary. Remember, if you can't get a good picture on one channel, try another. Depending on the values of C3 and C4, you will probably be able to tune from Channels 2 through 5.

Using the Game Unit

Generally, the games are pretty simple, yet can also be challenging. You can put "english" on the ball by striking it with a sliding motion; when the rebound angle is set to the larger setting, then the angle that the ball comes off of the paddle depends on what part of the paddle you strike with.

To stop the game from serving too soon after pressing the reset button, use the "Serve Pause" switch. Set it to pause prior to pushing reset.

The game keeps score automatically; all games end at the score of 15. The unit will keep serving and making sounds after this score is reached, but the paddles will be ineffective. Press reset to start a new game.

Occasionally, the unit will get confused and think it is displaying the ball when it isn't. Press reset, repeatedly if necessary, to correct this.

All things considered, the best way to learn the game is to play it. Although it isn't Mario Brothers, it is still a very entertaining way to pass the time; you and your family should get many hours of enjoyment from it. **NV**

Parts List

Semiconductors

U1	AY3-8500-1 video game IC
U2	CD4011B NAND gate IC
U3	74LS04 inverter IC
U4	CD4072B 4-input NOR gate IC
X1	2 MHz crystal
D1	High brightness red LED R.S. #276-088 or equiv.
Q1	2N2222 NPN transistor
Q2	78L05 5-volt regulator

Discrete Components

R1	1 M-ohm 1/8W resistor 5%
R2	1 K-ohm 1/8W resistor 5%
R3	330 ohm 1/8W resistor 5%
R4	270 ohm 1/8W resistor 5%
R5, R6	1 M-ohm potentiometer linear taper (RS #271-211 or equiv.)
R7	100 K-ohm PCB-mount trimmer pot
R8	1 K-ohm 1/8W resistor 5%
R9	220-ohm 1/8W resistor 5%
R10	470-ohm 1/8W resistor 5%
C1, C2	22 pF ceramic disc capacitor
C3	trimmer capacitor 10-100 pF or similar (see text)
C4	47 pF mica capacitor (or as required; see text)
C5, C6	.047 mF tantalum capacitor
C7-C9	.1 mF tantalum capacitor

Jacks & Switches

J1, J5, J6	RCA-type phono jack, case mount, RS #274-346 or equiv.
J2	F-61 Female coax jack RS #278-212 or equiv.
J3, J4	Double phono jack RS #274-332 or equiv.
S1	SPST N.O. momentary push-button RS #275-1556 or equiv.
S2	6 position double pole rotary switch (DP6T) RS #275-1386 or equiv.
S3-S6	SPST mini toggle switch RS #275-634 or equiv.

Misc.

	Blank printed circuit board single sided 3" x 3.5"
	Power connector: either 9V battery clip w/9V battery OR DC power connector (RS #274-1565 or equiv.) and 9V power supply (RS #273-1455 or equiv.)
	8W speaker RS #40-1333 or equiv.
	Main Unit enclosure (RS #270-272 or equiv.)
	Paddle control enclosures (two required) (RS #270-220 or equiv.)
	2 — phono cables for paddle controls
	Screws, nuts, standoffs as required

Availability

Most of the parts required are available at any of the normal electronics parts sources. As you can see, I have given Radio Shack part numbers for many of the items, not because I think that Radio Shack is the best or the cheapest, but because there are so many of them (I have seen towns that have only a General Store/Post Office and a Radio Shack). You will save considerable money by looking around for the best price, particularly with the switches, speaker, and 9V adapter.

The AY-3-8500-1 chip is the only difficult-to-find part; you can get it for about 95 cents (as well as many other required parts) from:

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11691D, DIRECTIONAL COUPLER, 22 dB, 2-18 GHz	\$500.00	1241, COI /R LOGIC ANALY, w/ TWO D2 CARDS, 36 CHANNEL	reduced! \$2000.00	GENERAL MICROWAVE 476, POWER METER	\$150.00
11720A, PULSE MODULATOR, 2-18 GHz	\$1200.00	144, NTS: TEST SIGNAL GENERATOR	\$700.00	GENERAL RADIO 4764240A, PWR METER/HEAD, TO 18GHz, SMA INPUT	\$400.00
11975A, AMP, 2-8 GHz, W/DIODE BIAS FOR HARMONIC MIXERS	\$950.00	1401A/321, BATT PWRD SPEC ANALYZER, 1-500 MHZ	\$1000.00	GENERAL RADIO 4764240A, PWR METER/HEAD, TO 18GHz, N INPUT	\$350.00
141T, DISPLAY	\$550.00	184, TIME MARK GENERATOR	\$50.00	GOULD, 816, DUAL PIN PORT RECORDER	\$350.00
141T8552A/8553, SPECTRUM ANALYZER, 1 kHz-110 MHz	\$1800.00	2113, 60 MHz DUAL VERT/TIME	\$700.00	GUILDLINE, 91540, TRANSVOLT 4890 STANDARD CELLS	\$750.00
141T8552A/8554, SPECTRUM ANALYZER, 100 kHz-1.25 GHz	\$2000.00	326, 15 MHz MINI PORTABLE	\$400.00	HARRISON LABS 6206A, POWER SUPPLY	\$40.00
141T8552A/8555, SPECTRUM ANALYZER, 10 MHz-18 GHz	\$2250.00	434, 150 MHz STORAGE O'SCOPE	\$500.00	HITACHI V-151F, PORT. O'SCOPE	\$600.00
141T8552A/8556, SPECTRUM ANALYZER, 20 Hz-300 kHz	\$1700.00	465 OR 465M, 100 MHz DUAL VERT/TIME O'SCOPE	\$550.00	HITACHI V-212, PORT. O'SCOPE	\$700.00
1707B, BATT. PWRD, DUAL CHANN. O'SCOPE, 75MHz	\$700.00	465B, 100MHz DUAL VERT/TIME O'SCOPE	\$675.00	HONEYWELL 1858/0700, OSCILLOGRAPH	\$2000.00
1722A, 100 MHz PORTABLE O'SCOPE	\$700.00	466, 100 MHz VERT/TIME STORAGE O'SCOPE	reduced! \$1100.00	IBM, SYSTEM 9000, CONTROLLER	\$3000.00
1722B, 275 MHz PORTABLE O'SCOPE	\$900.00	475, 200 MHz DUAL CHANNEL O'SCOPE	\$750.00	INTERSTATE F31, 3MHz FUNCTION GENERATOR	\$300.00
1740A, 100 MHz PORTABLE O'SCOPE	\$600.00	475A, 250 MHz DUAL CHANNEL O'SCOPE	\$825.00	INTERSTATE F72, 20MHz PULSE FUNCTION GENERATOR	\$450.00
1741A, 100MHz PORTABLE O'SCOPE	\$800.00	485, 350 MHz DUAL VERT/TIME O'SCOPE	\$950.00	INTERSTATE P23, PULSE GENERATOR	\$200.00
182T, DISPLAY SECTION	\$650.00	491, SPECTRUM ANALYZER, 10 MHz-12.4 GHz	\$950.00	INTERSTATE P24, PULSE GENERATOR	\$300.00
204C, AUDIO OSCILLATOR, 5 Hz-1.2MHz	\$250.00	492, SPECTRUM ANALYZER, 50 kHz-21 GHz	reduced! \$5950.00	IREROLD 704B, CALIBRATED FIELD STRENGTH METER	\$300.00
313A, TRACKING GENERATOR, 10 kHz-22 MHz	\$250.00	496 SPECTRUM ANALYZER, 0.1-1.8 GHz	\$4000.00	KEITHLEY, 225, CURRENT SOURCE	\$350.00
3300A, FUNCTION GENERATOR, 0.1Hz-10MHz	\$300.00	5A22N, DIFFERENTIAL AMPLIFIER	\$400.00	KEITHLEY, 230, PROGRAMMABLE VOLTAGE SOURCE	\$875.00
3305, SWEEP PLUG-IN, 1Hz-100kHz	\$50.00	528, TELEVISION WAVEFORM MONITOR	\$500.00	KEITHLEY, 260, NANOVOLT SOURCE	\$300.00
3312A, 13 MHz FUNCTION GENERATOR	\$800.00	5440/D40, 50 MHz THREE SLOT FRAME	\$275.00	KEITHLEY, 261, PICOAMPERE SOURCE	\$350.00
331A, DISTORTION ANALYZER	\$225.00	576, CURVE TRACER	\$1500.00	KEITHLEY, 616, DIGITAL ELECTROMETER	\$400.00
3310A, FUNCTION GENERATOR, 0.05Hz-5MHz	\$325.00	577/D2, CURVE TRACER, NEW	reduced! \$1000.00	KEITHLEY, 705/247158, LO-CURR SCANNING SYSTEM, GPIB	\$500.00
333, DISTORTION ANALYZER	\$425.00	7A13, DIFFERENTIAL COMPARATOR, LED DISPLAY	reduced! \$400.00	KEPCO K560-2, 60V 2A POWER SUPPLY	\$150.00
334, DISTORTION ANALYZER	\$625.00	7A13, DIFFERENTIAL COMPARATOR, MECH. DISPLAY	\$300.00	KEPCO APH 1000M, 0-1000V @ 0.20MA POWER SUPPLY	P.U.R.
339, DISTORTION ANALYZER	\$2000.00	7A14, CURRENT PROBE AMPLIFIER, 120 MHz	\$175.00	KEPCO ATE-610M, 6V AT 10A CVCC POWER SUPPLY	\$100.00
3400, RMS VOLTMETER	\$300.00	7A18, 75 MHz DUAL TRACE AMPLIFIER	\$100.00	KEPCO ATE-75-25-3M, 75V AT 3A CVCC POWER SUPPLY	\$300.00
3403C, TRMS DMM, 3.5 DIGIT, 10kHz-1.6 Hz	\$450.00	7A19, 600 MHz AMPLIFIER	\$250.00	KEPCO BOP-36-15M, 36V AT 1.5A BIPOLAR OP AMP/POWER SUPPLY	\$275.00
3406A, BROADBAND SAMPLING VOLTMETER	\$800.00	7A22, DIFFERENTIAL AMPLIFIER	reduced! \$500.00	KEPCO BOP-72-15M, 72V AT 1.5A BIPOLAR OP AMP/POWER SUPPLY	\$400.00
3437A, HIGH SPEED SYSTEM DMM 1000 R/SEC HP1B	\$350.00	7A24, 400 MHz DUAL TRACE AMPLIFIER	\$450.00	KEPCO BOP-72-5M, 72V AT 5A BIPOLAR OP AMP/POWER SUPPLY	\$600.00
3440/3444A, DIGITAL MULTIMETER	\$75.00	7A26, 200 MHz DUAL TRACE AMPLIFIER	reduced! \$200.00	KEPCO BOP-1000M, 1000V AT 40mA BIPOLAR OP AMP/POWER SUPPLY	\$600.00
3455A, 6-1/2 DIGIT DMM	\$700.00	7A29, 1 GHz VERT PLUG	\$800.00	KEPCO JQE 0-6V-10A, 6V @ 10 AMP	\$75.00
3467A, LOGGING MULTIMETER, 4.5	\$1000.00	7A42, 4 CHANNEL LOGIC TRIG VERT AMP, 350 MHz	\$1500.00	KEPCO JQE 15-6MVP, 15V @ 6A	\$150.00
3469B, MULTIMETER, ANALOG/DIGITAL READOUT	\$275.00	7B10, DELAY TIME 2nd/2nd DELTA TIME	\$350.00	KEPCO JQE 25-10M 25V AT 10A CVCC POWER SUPPLY	\$275.00
3490A, DMM, 5 DIGIT	\$275.00	7B15, DELAY TIME 2nd/2nd	\$400.00	KEPCO JQE 36-3MVP, 36V AT 3A CVCC METERED SUPPLY	\$300.00
3555B, TRANSMISSION & NOISE MEASUREMENT SET	\$200.00	7B33A, 100MHz DUAL TIME BASE	reduced! \$200.00	KEPCO JQE 36V-3A, 36V @ 3 AMP	\$300.00
3581A, WAVE ANALYZER, 15 Hz-50 kHz	\$1200.00	7B80, 400MHz DELAYED TIME BASE	\$200.00	KEPCO JQE 55-10M, 55V AT 10A CVCC POWER SUPPLY	\$350.00
3581C, SELECTIVE VOLTMETER, 15Hz-50KHz	\$1500.00	7B85, 400MHz DELTA TIME DELAYING TIME BASE	\$250.00	KEPCO JQE 100-25MVP, 100V AT 25A CVCC METERED SUPPLY	\$500.00
3582A, SPECTRUM ANALYZER, 0.2 Hz-25.599 KHz	\$5000.00	7B92A, 500MHz DUAL TIME BASE	\$450.00	KEPCO JQE 100V-2.5, 0-100V 0-2.5 AMP	\$300.00
3586B, SELECTIVE LEVEL METER	\$1000.00	7D01, LOGIC ANALYZER PLUG	\$200.00	KIKUSUI, 5509, O'SCOPE, 15MHz, 4 CH	\$250.00
3702A, IF/BB RECEIVER	\$2000.00	7D02/PM111, LOGIC ANALYZER W/6809 POD	\$450.00	KIKUSUI 5513, O'SCOPE	\$300.00
400E, AC VOLTMETER	\$55.00	7D10, DIGITAL EVENT DELAY	\$200.00	KIKUSUI, COS6100, 5-CHANNEL 100 MHz O'SCOPE	\$525.00
410C, VOLTMETER	\$150.00	7D13, 3.5 DIGIT DMM	\$125.00	LAMBDA LH121FM, 20V @ 3A, REGULATED POWER SUPPLY	\$185.00
415E, SWR METER	\$150.00	7D15, 225MHz UNIVERSAL COUNTER/TIMER	\$100.00	LEADER 480-U71, TV-IF PLUG IN UNIT	\$300.00
419, DC NULL METER	\$75.00	7D20T, PROGRAMMABLE DIGITIZER	\$2500.00	LEADER LDM 170, DISTORTION METER	\$400.00
431, POWER METER	\$75.00	7L12/7623A, SPECTRUM ANALYZER SYSTEM	reduced! \$1750.00	LEADER LMS-3100, TV SOUND MONITOR	\$300.00
431B, POWER METER	\$100.00	7L13/7623A, SPECTRUM ANALYZER SYSTEM 10kHz-1800MHz	reduced! \$2150.00	LH RESEARCH 137A, PULSE GENERATOR, 125MHz-10Hz	\$300.00
431C, POWER METER	\$150.00	7L18, SPECTRUM ANALYZER DISPLAY	reduced! \$3000.00	MAGNAVOX T-21893, CHART PRINTER	\$200.00
432A/478A, POWER METER, 0.01-10 GHz, -20 dBm TO +10 dBm	\$300.00	7M11, DELAY LINE	\$150.00	MARCONI, TF2300B, AM/FM MOD METER	\$500.00
435A, POWER METER	\$450.00	7S11, SAMPLING UNIT	\$400.00	MARCONI 2304, MOD. METER	\$400.00
435A/4481B, PWR METER W/SENSOR, 1 mW-25 W, 0.01-18 GHz	\$1325.00	7S12/S6552/7603, TDR SAMPLING SYSTEM W/S6552	\$1950.00	MARCONI 2337A, AUTOMATIC DISTORTION METER	\$400.00
456-022 HP1B, PROG. DIGITAL POWER METER	\$900.00	7T11, SAMPLING SWEEP UNIT	\$900.00	MARCONI, TF 2370/TK 2373, SPECTR. ANAL., 0-1250 MHz	\$3000.00
461A, AMPLIFIER	\$200.00	7625A, MULTIMODE STORAGE O'SCOPE, 100MHz	reduced! \$375.00	MAYNARD, MAINSTREAM 150, 150MB EXT. TAPE DRIVE FOR PS/2,	UNUSED & COMPLETE
4800A/4801A, VECTOR IMPEDANCE METER, 5 Hz-500 kHz	\$550.00	7633, 100 MHz STORAGE, 1000cm/s WRITING	reduced! \$500.00	MEASUREMENTS CORPORATION 80, SIGNAL GENERATOR	\$300.00
491C, AMPLIFIER, TWT, 2-4 GHz, 1W 30dB GAIN	\$2000.00	7704, 150 MHz FOUR SLOT FRAME	reduced! \$250.00	MICRO TECHNICAL INDUSTRIES 358, THERMO PROBE	\$400.00
4935A/003, TRANSMISSION TEST SET, AC & BATT. PWRD.	\$1250.00	7704A, 250 MHz FOUR SLOT FRAME	reduced! \$325.00	MICROTEK SG800, SWEEP SIG. GEN., 1GHz-18GHz	\$3000.00
5004A, SIGNATURE ANAL. W/PROBES	\$150.00	7834, 400 MHz STORAGE, 2500 cm/s WRITING	\$750.00	MILLIVAC 828A	\$300.00
5253B, FREQUENCY CONVERTER, 18 GHz	\$350.00	7834, 400 MHz SYSTEM, W/(1)7A24, (1)7A26, (1)7B80, (1)7B85	reduced! \$1150.00	MILLIVAC, MV-823B-S1, RF MILLIVOLTMETER, 10 kHz-1.2 GHz, 1mV-10V,	W/ADAPTERS
5305B/5300B/001, 1.3 GHz COUNTER WITH TCXO REF	\$450.00	7844, 400 MHz DUAL BEAM FRAME	reduced! \$900.00	NARDA 7000A W/7202 MICROWAVE UNIT, 0.1-2GHz	\$1500.00
5314A, 100 MHz/100 mS UNIV. COUNTER, PORTABLE	\$250.00	7904, 500 MHz SYSTEM, W/(1)7A19, (1)7A26, (1)7B80, (1)7B85	\$1000.00	NOBATRON QR36-4AP, 40V 5A	\$750.00
5326C, UNIVERSAL COUNTER, 50MHz	\$100.00	7904, 500 MHz FOUR SLOT FRAME	reduced! \$450.00	PHILLIPS 3226, O'SCOPE	\$300.00
5328A, TIMER/COUNTER, 500MHz, DUAL CHANNEL	\$250.00	AM501, OPERATIONAL AMP	\$100.00	PHILLIPS 5512, NTSC TV PATTERN GENERATOR	\$250.00
6033A, AUTOARRANGE SYSTEM PWR SUPP, 200W-20V/30A, HP1B	\$1250.00	DC5004, COUNTER/TIMER	\$475.00	PHILLIPS FM2454B, AC MILLIVOLTMETER	\$200.00
6110A, 3000V AT 6mA DUAL POLARITY POWER SUP.	\$275.00	DC5009/01, PROG. 135 MHz UNIVERSAL COUNTER, TCXO	\$750.00	PHILLIPS FM2554, AC MILLIVOLTMETER	\$250.00
6111A, PRECISION POWER SUPPLY, 0-20V, 0-1A	\$275.00	DC5010, PROG. 350 MHz UNIV. COUNTER	\$1350.00	PHILLIPS FM3225, O'SCOPE	\$300.00
6130B, BIPOLAR DIGITAL PROG. PWR. SUPPLY, +/-500A	\$600.00	DC503, DIGITAL COUNTER PLUG-IN, 100 MHz	\$350.00	PHILLIPS FM5107, LOW DIST LF GENERATOR	\$250.00
6131B, CVCC PROG. +/-1000SA	\$1500.00	DC503A, 125 MHz UNIVERSAL COUNTER	\$500.00	PHILLIPS FM6302, RCL BRIDGE	\$250.00
6186B, DC CURRENT SOURCE, TO 300V, 100mA	\$600.00	DC504, COUNTER/TIMER, 1Hz-80MHz	\$185.00	PHILLIPS FM6611, UNIVERSAL COUNTER	\$250.00
6200B, 40V/20V AT 0.3A/0.6A CVCC POWER SUPPLY	\$200.00	DC505A, 225 MHz UNIVERSAL COUNTER	\$250.00	POWER DESIGNS, 2005A, PRECISION POWER SOURCE, TO 20V, 500mA	\$200.00
6201, 0-20VW 0-1.3, (THREE UNITS)	\$175.00	DC509, 135 MHz UNIVERSAL COUNTER/TIMER	\$700.00	POWER DESIGNS 2020, 20V 2A	\$75.00
6201A, 20V @ 2A POWER SUPPLY	\$200.00	DD501, DIGITAL DELAY	reduced! \$350.00	POWER DESIGNS, 2K-10-0-2000V 0-10mA CV POWER SUPPLY	\$200.00
6206B, 60V 5A/30V 1A, POWER SUPPLY	\$200.00	DM5010, PROGRAMMABLE 4.5 DIGIT DMM	reduced! \$350.00	POWER DESIGNS TW5005, 50V 5A	\$75.00
6218A, 60V @ 250 mA, POWER SUPPLY	\$150.00	DM501A, MULTIMETER, 4.5 DIGIT	\$300.00	POWER DESIGNS 5015, 50V 1.5A	\$100.00
6223A, 20V 6A, POWER SUPPLY	\$75.00	DM501, DMM MODULE, 4.5 DIGIT DISPLAY	\$275.00	POWER DESIGNS, 6050A, UNIV. DC SOURCE, TO 60V, 5A	\$200.00
6253A, DUAL OUTPUT SUPPLY, 20V AT 3A	\$450.00	DM502, MULTIMETER, 3.5 DIGIT	\$175.00	RACAL-DANA SERIES 6000, MICROPROCESSING DMM	\$350.00
6255A, DUAL OUTPUT SUPPLY, 40V AT 1.5A	\$450.00	DM502A, MULTIMETER, 3.5	\$225.00	RACAL-DANA SERIES 9000, TIMER/COUNTER, 9 DIGIT	\$250.00
6264B, 20V AT 20A CVCC POWER SUPPLY	\$500.00	FG501, 1 MHz FUNCTION GENERATOR	reduced! \$250.00	RACAL-DANA, 1250, UNIV. SWITCH CONTROLLER	\$300.00
6267B, 0 TO 400 @ 10A CVCC POWER SUPPLY	\$700.00	FG502, 11 MHz FUNCTION GENERATOR	reduced! \$250.00	RACAL-DANA, 5004, 5-1/2 DIGIT BENCH MULTIMETER, GPIB	\$250.00
6267B/011, 40V AT 10A CVCC POWER SUPPLY, W/OVP	\$550.00	FG503, 3 MHz FUNCTION GENERATOR	reduced! \$250.00	RADIO RESEARCH 41, AM/FM SIGNAL GENERATOR	\$200.00
6282A, 10V AT 10A CVCC POWER SUPPLY	\$275.00	FG504, 40 MHz FUNCTION GENERATOR	reduced! \$900.00	RADIOMETER COPENHAGEN SMGI, STEREO GENERATOR	\$500.00
6284A, 0-20V DC @ 3A DC POWER SUPPLY	\$275.00	PG015, PROBE, 1000X, 40kV, AC/DC	\$300.00	RFL INDUSTRIES 829G, AC/DC CALIBRATION STANDARD	\$1700.00
6291A, 40V AT 5A CVCC POWER SUPPLY	\$375.00	PG501, 50 MHz PULSE GEN	\$300.00	SHIBASOKU AS9538, MPX TV SOUND SIGNAL GENERATOR	\$600.00
6299A, 100V AT 750mA CVCC POWER SUPPLY	\$275.00	PG508, 50 MHz PULSE GEN	\$500.00	SILVERLINE, 103-2.51, 25 KVAC HPOT	\$300.00
6439B, 0-60V DC @ 15A DC	\$600.00	PS501, 2, POWER SUPPLY			

WESTERN TEST SYSTEMS

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OSCILLOSCOPES & ACCESSORIES

TO 100 MHz

TEK 5440 50 MHz 4-Trace Oscilloscope System, w/(2)5A48, 5B42	\$750.00
TEK 5A13N Differential Comparator	\$300.00
TEK 5A18N 2 MHz Dual Trace Amplifier	\$125.00
TEK 5A19N 2 MHz Differential Amplifier	\$175.00
TEK 5B10N 2 MHz Time Base / Amplifier	\$100.00
TEK 7603 100 MHz 3-slot frame	\$250.00
TEK 7A13 100 MHz Differential Comparator Amp., LED display	\$400.00
TEK 7A18 75 MHz Dual Trace Amplifier	\$100.00
TEK 7A22 1 MHz High CMRR Differential Amplifier	\$400.00
TEK 7B53A 100 MHz Dual Time Base	\$200.00
TEK 7A65B 100 MHz Dual Channel O'scope, rackmount	\$550.00
TEK 7R603 100 MHz Rackmount Oscilloscope frame	\$250.00
TEK SC502 15 MHz Dual Trace	\$375.00
Oscilloscope plug-in, TM500 series	

ABOVE 100 MHz

TEK 7844 400 MHz Dual Beam 4-slot frame	\$750.00
TEK 7904 500 MHz 4-slot frame	\$500.00
TEK 7904 500 MHz System, with 7A24, 7A26, 7B80, 7B85	\$1,200.00
TEK 7A24 400 MHz Dual Trace Amplifier	\$450.00
TEK 7A26 200 MHz Dual Trace Amplifier	\$250.00
TEK 7A29-opt.04 1 GHz Amplifier, variable delay	\$1,150.00
TEK 7B10 1 GHz Time Base	\$500.00
TEK 7B15 1 GHz Delaying Time Base	\$600.00
TEK 7B80 400 MHz Delaying Time Base	\$200.00
TEK 7B85 400 MHz Delta Delaying Time Base	\$250.00
TEK 7B87 400 MHz Time Base, with pretrigger acquire clock (7B84)	\$250.00
TEK 7B92A 500 MHz Dual Time Base	\$450.00

STORAGE

TEK 214 500 kHz Dual Trace Mini Storage O'scope, AC/batt. power	\$450.00
TEK 5441 50 MHz 4-Trace Oscilloscope System, w/(2)5A48, 5B42	\$850.00
TEK 7834 400 MHz Storage 4-slot frame	\$750.00
TEK 7834 400 MHz Storage System, with 7A24, 7A26, 7B80, 7B85	\$1,250.00
TEK SC503 10 MHz Dual Trace	\$700.00
Storage Oscilloscope, TM500 series	

DIGITAL

HP54100D 1 GHz Repetitive/40 MS/s Digital Oscilloscope	\$3,250.00
TEK 468 100 MHz Analog / 10 MS/s Digital Oscilloscope	\$1,500.00
TEK 7854 400 MHz Waveform Processing frame, digital storage	\$1,500.00

SAMPLING

TEK 7S11 Sampling Unit	\$450.00
TEK 7S14 1 GHz Dual Channel Sampling Unit	\$700.00
TEK 7T11 Sampling Sweep Unit	\$950.00
TEK S-4 14 GHz Sampling Head, for 7S11 or 7S12	\$750.00
TEK SD-14 3 GHz Dual Sampling Head, for 11B01A, etc.	\$2,500.00
TEK SD-22 12.5 GHz Dual Sampling Head, for 11B01A, etc.	\$2,500.00

PROBES

TEK 1101A Active Probe Power Supply	\$225.00
TEK A6902 Voltage Isolator, dual channel, 1.5 kV/chan., DC-15 MHz	\$650.00
TEK A6902B Voltage Isolator, dual channel, 500 V/chan., DC-20 MHz	\$950.00
TEK P6007-opt.01 100X 20 MHz 1.5kV Probe, 3.5 feet length (NEW/BOXED)	\$75.00
TEK P6046 100 MHz 1X/10X Differential FET Probe	\$750.00
TEK P6150 9 GHz 10X / 3 GHz 1X Low Impedance Probe	\$600.00
TEK P6201 900 MHz FET Probe, 1X/10X/100X	\$400.00

CALIBRATION

TEK SG503 Levelled Sine Wave Generator, 0.25-250 MHz, TM500 series	\$850.00
TEK TG501 Time Mark Generator, 1N5-5S, TM500 series	\$750.00

WAVEFORM GENERATORS

FUNCTION

HP3310A 5 MHz Function Generator	\$325.00
HP3310B 5 MHz Function Generator, monocyte & burst operation	\$425.00
HP3312A 13 MHz Function Generator, AM, FM, sweep capability	\$800.00
HP8111A 20 MHz Pulse/Function Generator	\$1,500.00
TEK DD501 Digital Delay & Burst Gen., for function & pulse gen's	\$375.00
TEK FG502 11 MHz Function Generator, TM500 series	\$325.00
TEK FG504 40 MHz Function Generator, TM500 series	\$875.00
TEK RG501 Ramp Generator, TM500 series	\$225.00
WAVETEK 132 2 MHz VCG / Noise Generator	\$600.00
WAVETEK 164 30 MHz Sweep/Function Generator	\$850.00
WAVETEK 168 50 MHz Pulse/Function Generator	\$1,250.00

PULSE

COLBY PG-5000A 5 GHz 2-Channel Pulse Gen. requires external RF source	\$2,200.00
HP214B 10 MHz Pulse Generator, 50 V/50 Ohms, auto duty cycle	\$2,250.00
HP8012B 50 MHz Pulse Generator	\$600.00

HP8015A-002 50 MHz Dual Output Pulse Generator, burst operation	\$700.00
HP8080A/81A/82A/83A 300 MHz Word Generator	\$900.00
HP8080A/91A/92A/93A 1 GHz Dual Channel Pulse Generator	\$1,650.00
HP8080A/91A/92A/93A 1 GHz Single Channel Pulse Generator	\$1,400.00
HP8080A/91A/93A 1 GHz Clock Generator	\$900.00
HP8082A 250 MHz Pulse Generator	\$1,400.00
TEK PG501 50 MHz Pulse Generator, TM500 series	\$300.00
TEK PG502 250 MHz Pulse Generator, Tr<1nS, TM500 series	\$700.00
TEK PG505 100 kHz Pulse Generator, 80V, TM500 series	\$275.00
WAVETEK 801 50 MHz Pulse Generator	\$550.00

PROGRAMMABLE

HP3325A Synthesized Function Generator, 1 uHz-21 MHz, GPIB	\$2,400.00
HP8116A 50 MHz Pulse/Function Generator, GPIB	\$3,000.00
HP8165A Programmable Signal Source, 1 mHz-50 MHz	\$2,600.00
STANFORD RESEARCH DG535 Digital Delay Generator, 4 channels, 5 pS res., GPIB	\$1,500.00
TEK AWG5105 Arbitrary Waveform Generator, 50 MS/s, 12 bits	\$3,000.00
TEK AWG5105-opt.02 Arbitrary Waveform Generator, dual channel option	\$4,250.00
TEK PFG5505 Programmable 12 MHz Pulse/Function Generator	\$1,275.00
WAVETEK 278-opt.02 12 MHz Programmable Synthesized Function Gen., GPIB	\$1,500.00

VOLTAGE & CURRENT

VOLTMETERS

FLUKE 8840A-059 5-1/2 Digit Programmable Multimeter	\$550.00
KEITHLEY 181 6-1/2 digit Nanovoltmeter, 10 nV sensitivity, GPIB	\$1,500.00
KEITHLEY 194A High Speed Voltmeter, single channel, GPIB	\$650.00
SOLARTRON 7150 5-1/2 / 6-1/2 digit Multimeter, GPIB	\$550.00
TEK DM511-opt.02 4-1/2 Digit DMM, w/P6602 Temp. Probe; TM500 (NEW/BOXED)	\$395.00

CALIBRATION

E.S.I. RV722 7-Decade Kelvin-Varley Voltage Divider	\$1,675.00
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VOLTAGE SOURCES

HP6114A Precision Dual Range Power Supply, 20 V 2 A / 40 V 1 A	\$875.00
HP6115A Precision Dual Range Power Supply, 50V 0.8A / 100V 0.4A	\$875.00

CURRENT METERS & SOURCES

HP6177C DC Current Source, to 50V, 500mA	\$600.00
HP6181C DC Current Source, to 100 V, 250 mA	\$675.00
HP6186C DC Current Source, to 300V, 100mA	\$750.00
KEITHLEY 220 Programmable Current Source, 0.5 pA-101 mA, GPIB	\$2,000.00
KEITHLEY 225 Current Source, 1 nA-99.9 mA, 10-100 V compliance	\$450.00
KEITHLEY 227 Current Source, 1 uA-1 A, 10-300 V compliance	\$750.00
KEITHLEY 228 Prog. Voltage/Current Source, sink or source 100 Watts	\$2,250.00
KEITHLEY 261 Picoampere Source, 10 fA-10 mA	\$325.00
KEITHLEY 414A Picoammeter, 0.1 nA-10 mA, analog scale	\$375.00
KEITHLEY 642 Electrometer	\$3,900.00
LEEDS & NORTHRUP 4360 Precision Current Shunts, 15-500 Amp	\$650.00
TEK CT-5 High Current Transformer for P6021/A6302, to 1000A	\$650.00
VALHALLA 2575A AC/DC Wideband Active Shunt, 20 mA-100 A	\$1,200.00

IMPEDANCE & COMPONENT TEST

IMPEDANCE

HP 4800A Vector Impedance Meter, 5 Hz-500 kHz	\$550.00
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L.C.R.

BOONTON 62AD 1 MHz Inductance Meter, 2-2000 uH	\$700.00
BOONTON 72BD 1 MHz Digital Capacitance Meter, 2-2000 pF	\$700.00
E.S.I. 2160 LCR Bridge, 20 Hz-150 kHz	\$2,000.00
E.S.I. 296V 4-1/2 Digit LCR Bridge, 120 Hz & 1 kHz	\$850.00
GR 1657 LCR Digibridge, 120 Hz/1 kHz	\$750.00
HP 4262A 3-1/2 digit LCR Meter, 120 Hz/1 kHz/10 kHz	\$1,600.00
HP 4328A-001 Milliohmeter, 0.001-100 ohms f.s., battery option	\$1,350.00
HP 4342A Q Meter, 22 kHz-70 MHz, Q=5-1000	\$2,250.00
MEGURO MQ-171 VHF Q Meter, 20-230 MHz, Q=10-500, freq. readout 100 Hz	\$1,100.00

STANDARDS

E.S.I. RS-925 9-Decade Resistor, 0.01 ohm-1.2 Megohm	\$2,000.00
E.S.I. SR1010 Resistance Transfer Standards, 1 ohm-100 K/step	\$800.00
FLUKE 5450A Programmable Resistance Standard, 2 & 4 wire	\$2,750.00
GR 1409-SERIES Standard Mica Capacitors, 0.05% accuracy	\$150.00
GR 1432-N 5-Decade Resistor, to 11,111 ohms, 0.1 ohm res.	\$275.00
GR 1432-U 4-Decade Resistor, 0-111.10 ohms, 0.01 ohm resolution	\$175.00
GR 1433-X 6-Decade Resistor, to 111,111.0 ohms, 0.1 ohm res.	\$550.00
HP 16470B Stable Inductors, set of 4	\$500.00
LEEDS & NORTHRUP 4220-SERIES Milliohm Standards	\$650.00

HIPOT

ROD-L M500AV 5000 Volt AC HIPOT Tester	\$700.00
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CURVE TRACERS

TEK 576 Curve Tracer, to 220W	\$2,350.00
TEK 577D1/177 Storage Curve Tracer, with standard test fixture	\$2,250.00
TEK 577D2/177 Curve Tracer, to 100W, with standard test fixture	\$1,750.00
TEK 7CT1N Curve Tracer, to 0.5V, 7000 series	\$500.00

T.D.R.

TEK 1503-opt.04 Time Domain Reflectometer, 0-50,000 feet, chart rec.	\$2,000.00
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POWER SUPPLIES

SINGLE OUTPUT

GLASSMAN PS/E-05R06 5KV CV/CL Power Supply, to 6mA	\$500.00
HP6002A-001 Programmable Power Supply, 0-50 V / 0-10 A / 200 Watts	\$875.00
HP6023A Autoranging Power Supply, to 20 V / 30 A / 240 Watts	\$1,150.00
HP6203B 7.5 V at 3 A CV/CC Power Supply	\$200.00
HP6206B Dual Range Power Supply, 30 V at 1 A / 60 V at 0.5 A	\$250.00
HP6207B 160V at 200mA CV/CC Power Supply	\$300.00
HP6209B 320V at 100 mA CV/CC Power Supply	\$300.00
HP6260B-027 10V at 100A CV/CC Power Supply	\$675.00
HP6261B-027 20 V at 50 A CV/CC Power Supply	\$675.00
HP6264B-011 20 V at 20 A CV/CC Power Supply, w/overvoltage crowbar	\$500.00
HP6266B 40V at 5A CV/CC Power Supply	\$400.00
HP6267B 40 V at 10 A CV/CC Power Supply	\$550.00
HP6289A 40 V at 1.5 A CV/CC Power Supply	\$250.00
HP6296A 60V at 3A CV/CC Power Supply	\$400.00
HP6299A 100 V at 750 mA CV/CC Power Supply	\$250.00
HP6384A 4.0-5.5V at 8A CV/CL Power Supply	\$200.00
HP6438B 60V at 5A CV/CC Power Supply	\$375.00
HP6443B 120V at 2.5A CV/CC Power Supply	\$475.00
KEPCO ATE-100-1M 100 V at 1 A CV/CC Power Supply	\$300.00
KEPCO JQE-36-15M 36 V at 15 A CV/CC Power Supply	\$375.00

MULTIPLE OUTPUT

HP6236B Triple Output Power Supply, variable tracking ratio	\$550.00
HP6253A Dual Output 20 V 3 A CV/CC Power Supply	\$500.00
HP6255A Dual Output 40 V 1.5 A CV/CC Power Supply	\$500.00
HP6621A System Power Supply, dual outputs to 20V 7A / 7V 10A	\$2,200.00
TEK PS503A Dual Power Supply, TM500 series	\$250.00

MISCELLANEOUS

ACME PS2L-1000 Programmable Load, to 75V / 150A / 1000 Watts	\$450.00
HP59501A GPIB Isolated DAC/Power Supply Programmer	\$175.00
HP6826A Bipolar Power Supply/Amplifier, to 50 V, 1 A	\$800.00
HP6827A Bipolar Power Supply/Amplifier, to 100 V, 500 mA	\$800.00
KEPCO BOP 100-1M Bipolar Op Amp/Power Supply, to 100 V, 1 A	\$500.00
KEPCO BOP 1000M Bipolar Op Amp/Power Supply, to 1000V, 40mA	\$600.00

TIME & FREQUENCY

UNIVERSAL COUNTERS

HP5314A 100 MHz/100 nS Universal Counter	\$225.00
HP5315A 100 MHz/100 nS Reciprocal Counter, high res. audio	\$550.00
HP5315A-001 100 MHz/100 nS Universal Counter, TCXO reference	\$650.00
HP5316A 100 MHz/100 nS Universal Counter, GPIB	\$750.00
HP5316A-001 100 MHz/100 nS Universal Counter, GPIB, TCXO reference	\$850.00
HP5316A-003 100 MHz/100 nS Universal Counter, GPIB, 1.0 GHz C-chan.	\$1,000.00
HP5370B-001 100 MHz Univ. Time Int. Counter, 20 pS single shot, OCXO	\$2,250.00
HP E1420A-010, 030 VXI card 200 MHz/2 nS Univ. Counter, TCXO & 2.5 GHz C-ch	\$1,500.00
RACAL-DANA 1992-04E, 55 100 MHz/5 nS Univ. Counter, 1.3 GHz C ch., OCXO & GPIB	\$950.00
TEK 7D15 225 MHz Universal Counter/Timer, 7000 series	\$275.00
TEK DC5004 Programmable 100 MHz/100nS Counter/Timer, TM500 series	\$475.00
TEK DC5009-opt.01 Programmable 135 MHz Univ. Counter/Timer, TCXO, TM5000	\$750.00
TEK DC503A 125 MHz Universal Counter/Timer, TM500 series	\$500.00
TEK DC509 135 MHz High Resolution Universal Counter/Timer, TM500	\$700.00
TEK TVC501 Time-Voltage Converter, TM500 series	\$700.00

FREQUENCY COUNTERS

HP5305B/5300B-001 1.3 GHz Counter Package w/TCXO ref., high res. audio	\$450.00
HP5340A-001, 006 18 GHz Frequency Counter, OCXO, +39 dBm limiter	\$1,900.00
HP5340A-001, 011 18 GHz Frequency Counter, OCXO reference, GPIB	\$1,900.00
HP5345/5355/5356A-006 Pulsed/CW Frequency Counter, 1.5-18.0 GHz, 75 nS pulse	\$3,500.00
TEK 7D14 525 MHz Frequency Counter, 7000 series	\$175.00



90 DAY WARRANTY PARTS AND LABOR • 10 DAY INSPECTION TEST EQUIPMENT WANTED CALL OR FAX LIST • OPEN ACCOUNTS



TEK DC502 550 MHz Frequency Counter, TM500 series	\$400.00
TEK DC504 80 MHz Frequency Counter	\$125.00

AUDIO & BASEBAND

SPECTRUM ANALYZERS

HP3580A-002 Spectrum Analyzer, 5 Hz-50 kHz, 1 Hz res., bal. input	\$1,850.00
HP3581A Wave Analyzer, 15 Hz-50 kHz	\$900.00
HP3586C Selective Level Meter, 50 Hz-32.5 MHz, 50 & 75 ohms	\$1,750.00
HP8558A LF Section, 20 Hz-300 kHz	\$500.00
TEK 5L4N Spectrum Analyzer, 20 Hz-100 kHz, 10 Hz res., 5000-series	\$850.00
TEK 7L5-opt.25/7603 Spectrum Analyzer, 20 Hz-5 MHz, w/tracking gen., display	\$2,250.00

DISTORTION ANALYZERS

HP333A Distortion Analyzer, 5 Hz-600 kHz, -60 dB, auto nulling	\$500.00
HP334A-001 Distortion Analyzer, 5 Hz-600 kHz, AM detector, VU	\$550.00
HP339A Distortion Analyzer, built-in low distortion osc.	\$2,400.00
TEK DA4084 Programmable Distortion Analyzer, 0.0025% THD, w/frame	\$1,500.00

RMS VOLTMETERS

FLUKE 8920A True RMS Voltmeter, 180 uV-700 V, 10 Hz-20 MHz	\$700.00
HP3400A RMS Voltmeter, 10 Hz-10 MHz	\$250.00

OSCILLATORS

HP239A Low Distortion Osc., 10 Hz-110 kHz, -95 dB THD to 20 kHz	\$575.00
HP3335A Synthesizer/Level Generator, 200 Hz-80 MHz	\$3,250.00
HP4204A Synthesizer, 10 Hz-1 MHz, 1 mV-30 V / 600 Ohms	\$350.00
ROCKLAND 5100 Synthesizer, 1 mHz-1.999999999 MHz	\$400.00
TEK SG505 Low Distortion Oscillator	\$800.00

FILTERS, MISCELLANEOUS

KROHN-HITE 3202 Dual HP/LP/BP/BR Filter, 20 Hz-2 MHz, 24 dB/octave	\$600.00
KROHN-HITE 3343 Dual Bandpass Filter, 0.01 Hz-100 kHz, 48 dB/octave	\$950.00
P.A.R. 189 Filter/Amplifier, 0.1 Hz-110 kHz, variable Q & gain	\$400.00
TEK AM502 Differential Amplifier, 0.1 Hz-1 MHz, TM500 series	\$575.00
WAVETEK/ROCKLAND 752A-002 Dual Low Pass Filter, 1 Hz-100 kHz, 115 dB/octave, GPIB	\$1,100.00

RF & MICROWAVE

SPECTRUM ANALYZERS

HP11517A/18A/19A/20A Harmonic Mixer, 12.4-40.0 GHz, for 8555A, 8565A	\$700.00
HP5371A Modulation Domain Analyzer, 125 mHz-500 MHz	\$5,900.00
HP8406A Comb Generator, 1/10/100 MHz increments, to 5 GHz	\$450.00
HP8443A Tracking Generator, 0.1-110 MHz, LED display	\$700.00
HP8444A Tracking Generator, 0.1-1300 MHz, for 8554B	\$800.00
HP8444A-059 Tracking Generator, 0.5-1500 MHz, for 8554, 8568, etc.	\$1,500.00
HP8552B IF Section	\$750.00
HP8553B RF Section, 1 kHz-110 MHz	\$500.00
HP8554B RF Section, 0.1-1250 MHz	\$800.00
HP8555A RF Section, 0.01-18 GHz	\$950.00
HP8555A/8552B/141T Spectrum Analyzer System, 10 MHz-18 GHz, 100 Hz res.	\$2,375.00
TEK 496P Spectrum Analyzer, 1 kHz-1.8 GHz, 30 Hz res., GPIB	\$5,500.00
TEK 7L12/7613 Spectrum Analyzer, 0.1-1800 MHz, with storage display	\$2,000.00
TEK TR501 Tracking Generator, 0.1-1800 MHz, for 7L12, 7L13	\$700.00
TEK TR503 Tracking Generator, 0.1-1800 MHz, for 492/4/5/6	\$1,750.00

NETWORK ANALYZERS

HP11685B Modulator, 0.15-18.0 GHz, for use with 8755/6/7	\$375.00
HP8405A Vector Voltmeter, 1-1000 MHz	\$700.00
HP8407A/8412A/8601A Network Analyzer, 100 kHz-110 MHz, with sweep generator	\$1,250.00
HP85020A Directional Bridge, 0.01-4.3 GHz, N(f), for 8755/6/7	\$750.00
HP85021A Directional Bridge, 0.01-18.0 GHz, APC7, for 8755/6/7	\$1,200.00
HP85050D APC7 Calibration Kit, for 8510 series	\$1,100.00
HP8505A-005/8503A/8501 Network An., 0.5-1300 MHz, S-parameters, storage norm.	\$6,000.00
HP8756A Scalar Network Analyzer	\$2,500.00
NARDA 7000A/7202/7206 Microwave Multimeter	\$1,950.00
System: scalar analysis 0.1-18 GHz	
WILTRON 560A/560-98K50 Scalar Network Analyzer, with VSWR Bridge 10 MHz-40 GHz	\$2,900.00

SIGNAL GENERATORS

BOONTON 1020 Synthesized Signal Gen., 0.15-540 MHz, GPIB	\$1,850.00
BOONTON 102C Signal Generator, 0.45-520 MHz, AM, FM	\$850.00
COMSTRON FS-2000-4 Synthesizer, 10 MHz-4 GHz, 1 uS speed, -140 dB noise	\$15,000.00
EPSCO EP250C/M8045H/M8060H Power Oscillator System, 200-1200 MHz, >200 Watts	\$3,250.00
FLUKE 6060A Synthesized Signal Generator, 0.1-1050 MHz, 10 Hz res.	\$3,750.00
GIGATRONICS 875/86 Levelled Multiplier, 26.5-40.0 & 50.0-75.0 GHz outputs	\$8,000.00
HP11720A Pulse Modulator, 2-18 GHz, Tr<10ns, >80 dB	\$1,200.00
HP85100V Frequency Mult., 10-15 GHz in / 50-75 GHz out >0 dBm	\$4,250.00
HP8616A Signal Generator, 1.8-4.5 GHz, AM, FM, Pulse	\$450.00

HP8640A Signal Generator, 0.5-512 MHz, AM, FM, analog readout	\$950.00
HP8640B Signal Generator, 0.5-512 MHz, AM, FM, freq. locking	\$1,500.00
HP8640B-002 Signal Generator, 0.5-1024 MHz	\$2,600.00
HP8654A Signal Generator, 10-520 MHz, calibrated AM, uncal. FM	\$650.00
HP8654B Signal Generator, 10-520 MHz, AM, FM	\$750.00
HP8656A Synthesized Signal Generator, 0.1-990 MHz, AM, FM, HP1B	\$3,500.00
HP86601A RF Plug-in, 10 kHz-110 MHz, for 8660 series	\$650.00
HP8660C/86602B/86633B Synthesized Signal Generator, 1-1300 MHz, AM, FM, HP1B	\$2,750.00
HP8660C/86603A-002/34A Synthesized Sig. Gen., 1-2600 MHz, phase mod. to 10 MHz	\$4,500.00
HP8660C/86603A/86633B Synthesized Signal Gen., 1-2600 MHz, 1 Hz res., AM, FM	\$4,250.00
HP8683B Signal Generator, 2.3-6.5 GHz, AM, WBFM, Pulse	\$5,000.00
WAVETEK 3000 Synthesized Signal Gen., 1-520 MHz, 1 kHz res., AM, FM	\$550.00
WILTRON 6742A Synthesizer/Sweep Generator, 18.0-26.5 & 26.5-40.0 GHz	\$9,000.00

SWEEP GENERATORS

EIP 928-opt.9201 Sweep Gen., 1.0-18.6 GHz, step atten., power sweep, GPIB	\$4,000.00
HP8620C Sweep Oscillator Frame	\$550.00
HP8620C-001 Sweep Oscillator Frame, BCD programmable	\$600.00
HP8620C-011 Sweep Oscillator Frame, HP1B programmable	\$675.00
HP86210A RF Plug-in, 3-350 MHz, +13 dBm levelled	\$450.00
HP86222A RF Plug-in, 0.01-2.4 GHz, +13 dBm levelled	\$1,400.00
HP86222A-002 RF Plug-in, 10-2400 MHz, 70 dB step attenuator	\$1,750.00
HP86222B-002 RF Plug-in, 10-2400 MHz, crystal markers, 0-70 dB atten	\$2,000.00
HP86240A RF Plug-in, 2.0-8.4 GHz, +16 dBm levelled	\$1,000.00
HP86241A RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled	\$500.00
HP86242D-004,008 RF Plug-in, 5.9-9.0 GHz, +10 dBm levelled	\$500.00
HP86250D-001 RF Plug-in, 8.0-12.4 GHz, +10 dBm levelled	\$500.00
HP86290A RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled	\$1,750.00
HP86290B RF Plug-in, 2.0-18.6 GHz, +10 dBm levelled	\$2,000.00
WAVETEK 1067 Sweep Generator, 1-400 MHz, +10 dBm, 75 ohms	\$500.00
WAVETEK/MARCONI 8910 Programmable Sweep Generator, 2-20 GHz, +10 dBm, GPIB	\$5,500.00

POWER METERS

BOONTON 42B/41-4B Analog Power Meter, with 1 MHz-12.4 GHz sensor	\$475.00
BOONTON 42B/41-4E Analog Power Meter, with 1 MHz-18 GHz sensor	\$650.00
BOONTON 42B/42A-S3 Analog Power Meter, with 1 MHz-8.4 GHz N(f) sensor	\$375.00
GENERAL MICROWAVE 476/4240A Power Meter & Sensor, 0.01-18 GHz, -35 to +10 dBm	\$375.00
HP11683A Range Calibrator, for 435/6/7/8 power meters	\$750.00
HP432A/478A Power Meter, 0.01-10 GHz, -20 dBm to +10 dBm F.S.	\$375.00
HP435A/8481A Power Meter, 10 MHz-18 GHz, -30 to +20 dBm	\$1,000.00
HP435A/8482A Power Meter, 0.1-4200 MHz, -30 to +20 dBm	\$1,000.00
HP435A/8482H Power Meter, 0.1-4200 MHz, -15 to +34 dBm	\$1,150.00
HP8482B 25 Watt Power Sensor, 0.1-4200 MHz, for 435/6/7/8	\$1,250.00
HPK486A WR42 Thermistor Mount, 18.0-26.5 GHz, for 432 series	\$400.00
HPQ486A Power Sensor, 33.0-50.0 GHz, WR22 waveguide	\$1,500.00
HPR486A WR28 Thermistor Mount, 26.5-40.0 GHz, for 432 series	\$400.00
WAVETEK 1034A Portable Analog Power Meter, 1 MHz-18 GHz	\$375.00

RF MILLIVOLTMETERS

BOONTON 9200A-01 RF Millivoltmeter, 10 kHz-1.2 GHz, GPIB	\$950.00
RACAL 9303 TRMS Level Meter, 18.0-26.5 GHz, for 432 series	\$875.00

AMPLIFIERS, MISCELLANEOUS

ALITECH 7615 Noise Generator, 0.01-1.3 GHz, 15 dB ENR	\$350.00
ALITECH 7616 Noise Source, 1.0-12.4 GHz, 15 dB ENR	\$375.00
BOONTON 82AD FM/AM Modulation Meter, 10-1300 MHz	\$1,000.00
E.N.I. 240L Amplifier, 50 dB, 20 kHz-10 MHz, 40 Watts	\$1,250.00
ENI 500LA Amplifier, 24 dB, 1.5-520 MHz, 300 mW	\$350.00
ENI 503L Amplifier, 40 dB, 2-510 MHz, 3 Watts	\$850.00
ENI 600L Amplifier, 24 dB, 8-1020 MHz, 150 mW	\$450.00
ENI A150 Amplifier, 55 dB, 0.3-35.0 MHz, 150 Watts	\$2,000.00
ENI A300 Amplifier, 55 dB, 0.3-35.0 MHz, 300 Watts	\$3,500.00
HP11715A Modulation Source	\$1,250.00
HP11975A Amplifier, 2-8 GHz, +6 to +16 dBm levelled output	\$1,200.00
HP493A TWT Amplifier, 30 dB, 4-8 GHz, 1 Watt	\$800.00
HP8447A Amplifier, 0.1-400 MHz, NF<7 dB, +6 dBm output	\$300.00
HP8447F-H64 Dual Amp., 9 kHz-50 MHz/28 dBG & 0.1-1300 MHz/25 dBG	\$1,100.00
M.P.D. LAB2-1020-2A Amplifier, 34 dB, 1.0-2.0 GHz, 2 Watts	\$1,000.00
M.P.D. LAB2-110-1E Amplifier, 30 dB, 100-1000 MHz, 1 Watt	\$700.00
M.P.D. LAB2-714-3A Amplifier, 34 dB, 0.7-1.4 GHz, 3 Watts	\$1,000.00
MAURY MICROWAVE MT7118A Cryogenic Noise Source, liquid nitrogen, DC-18 GHz, APC7	\$750.00
MICROWAVE SEMI. CORP. MC5112 Noise Source, 25.5 dB ENR, 1.0-12.4 GHz, N(m), +28 VDC	\$325.00
PANASONIC VP-8125A AM/FM/Stereo Gen., 0.1-110 MHz, 0.1 Hz res., 0.05% dist	\$850.00

COAXIAL & WAVEGUIDE

DEMORNAY-BONARDI DBD-460 WR28 75 Watt Load, 26.5-40.0 GHz	\$175.00
GENERAL INSTRUMENT A6100-REV B Dual Pol. Quad Ridge Conical Horn, 2-20 GHz, SWR<2.5	\$400.00

GR 874-LTL Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz	\$450.00
GR 900-LB Precision Slotted Line, 0.3-8.5 GHz, 50 Ohms 0.1% tol	\$450.00
HP11691D Directional Coupler, 22 dB, 2-18 GHz	\$500.00
HP11692D Dual Directional Coupler, 22 dB, 2-18 GHz	\$900.00
HP778D-011 Dual Directional Coupler, 20 dB, 100-2000 MHz	\$400.00
HP779D Directional Coupler, 20 dB, 1.7-12.4 GHz	\$375.00
HP8472A Crystal Detector, 10 MHz-18 GHz, neg. pol., SMA(m)	\$150.00
HP8473D PDB Diode Detector, 0.01-33.0 GHz, APC3.5(m)	\$300.00
HP8497K-004 Programmable Attenuator, 0-90 dB, DC-26.5 GHz, APC3.5	\$600.00
HP905A Coaxial Sliding Load, 1.8-18.0 GHz, APC7/N(m)/N(f)	\$300.00
HP909C-013 Precision Termination, DC-2 GHz, SWR<1.01, N(f)	\$150.00
HPK532A WR42 Frequency Meter, 18.0-26.5 GHz	\$500.00
HPK752D WR42 Directional Coupler, 20 dB, 18.0-26.5 GHz	\$400.00
HPR532A WR28 Frequency Meter, 26.5-40.0 GHz	\$500.00
KAY 432D Step Attenuator, 0-101 dB, DC-1 GHz, BNC(l/f)	\$125.00
KRYTAR 101040013K Directional Coupler, 13 dB, 1-40 GHz, K(f/f/f)	\$625.00
NARDA 26298 20 dB Attenuator, 150 Watts, DC-1 GHz, N(f/f)	\$200.00
NARDA 3000-SERIES Directional Couplers	\$150.00
NARDA 3020A Bi-Dir. Coupler, 30 dB/50-250 MHz / 20 dB/250-1000 MHz	\$325.00
NARDA 3090-SERIES Precision High Directivity Couplers	\$225.00
NARDA 4000-SERIES SMA Miniature Directional Couplers	\$75.00
NARDA 4203-6 Directional Coupler, 6 dB, 2-18 GHz, SMA(f/f/f)	\$225.00
NARDA 4456-4 4-Way Power Divider, 2-18 GHz, SMA(f)	\$175.00
NARDA 4700 Step Attenuator, 0-9 dB, DC-12.4 GHz, SMA(f/f)	\$175.00
NARDA 5070-SERIES Precision Reflectometer Couplers	\$300.00
NARDA 765-20 20 dB Attenuator, 50 Watts, DC-5 GHz, N(m/f)	\$125.00
NARDA 768-30 30 dB Attenuator, 20 Watts, DC-11 GHz, N(m/f)	\$125.00
PRD312AF1 WR28 E-H Plane Tuner, 26.5-40.0 GHz	\$350.00
TRGA510 WR28 Precision Rotary Vane Atten., 0-50 dB, 26.5-40 GHz	\$1,000.00
TRGB551 WR22 Frequency Meter, 33.0-50.0 GHz	\$550.00
TRGV520 WR15 Level Set Attenuator, 0-20 dB, 50-75 GHz	\$250.00
TRGV551 WR15 Frequency Meter, 50.0-75.0 GHz	\$600.00
TRGV561-20 WR15 Directional Coupler, 20 dB, 50-75 GHz	\$300.00
TRGV510 WR10 Precision Variable Attenuator, 0-50 dB, 75-110 GHz	\$1,000.00
WEINSCHEL 1515 Power Divider, DC-18 GHz, SMA(f/f/f)	\$125.00
WEINSCHEL 1579 Power Divider, DC-26.5 GHz, APC3.5(f/f/f) "NEW"	\$275.00
WEINSCHEL AS-4 Attenuator Set, 3/6/10/20 dB, DC-3 GHz & 1-10 GHz, N(m/f)	\$200.00
WILTRON 60A50-opt.1 SWR Bridge, 5-2000 MHz, APC7 test port, 46 dB dir.	\$550.00
WILTRON 64A50 SWR Bridge, 3-8 GHz, 36 dB directivity, APC7 test port	\$450.00
WILTRON 97SF50-1 Directional Bridge, 10 MHz-18 GHz, SMA(f), 38 dB dir.	\$1,500.00

LOGIC

HP5004A Signature Analyzer	\$150.00
HP5005A Signature Multimeter	\$350.00
HP5005B Signature Multimeter, TTL/CMOS/ECL, HP1B	\$750.00
HP8170A-002 Logic Pattern Generator, 2 MB/s, address driver option	\$1,400.00
TEK 1240(2x)D2 Logic Analyzer, w/(36) 50 MHz channels	\$1,500.00

COMMUNICATIONS

HP28687A LAN Wire Test Instrument, for 25 pair cable	\$750.00
HP3336B-001 Synthesizer/Level Generator, 10 Hz-21 MHz	\$650.00
HP4935A Transmission Test Set, 20 Hz-110 kHz	\$1,675.00
HP59401A HP1B Bus Analyzer	\$700.00
TEK 1410R-opt.04 NTSC Test Signal Gen. w/SPG2, TSG1, TSP1, TSG3, TSG5, TSG6	\$2,750.00
TEK 1411R-opt.04 PAL Test Gen. w/SPG2, TSG11, TSP11, TSG13, TSG15, TSG16	\$2,750.00
TEK 144 NTSC Test Signal Generator	\$675.00
TEK 147A NTSC Test Signal Generator, with noise test signal	\$950.00
TEK 1485R Dual Standard Waveform Monitor, NTSC & PAL	\$1,850.00
TEK 521A PAL Vectorscope	\$1,500.00
WANDEL & GOLTERMANN RM-4 Radiolink Measuring Set, 70 MHz	\$1,750.00

MISCELLANEOUS

FLUKE 2190A/2300A/1120A 10-Chan. Scanning Thermometer, types J,K,T,R,C, GPIB	\$875.00
FLUKE 2190A/Y2003/Y2001 Temperature Calibration System	\$950.00
HP3488A Switch/Control Unit	\$950.00
HP59307A HP1B VHF Switch	\$200.00
P.A.R. 5205-94,95,96,98 Lock-In Amp, 20 Hz-20 kHz, int. osc., lin/log, GPIB	\$2,750.00
P.A.R. 5206 Two-Phase Lock-In Amplifier, 2 Hz-200 kHz	\$3,000.00
TEK J16J6523 Photometer, with Spot Luminance Probe	\$900.00
TEK TM5006 5000-series 6-slot Programmable Power Module	\$600.00
TEK TM503 500-series 3-slot Power Module	\$175.00
TEK TM504 500-series 4-slot Power Module	\$175.00
TEK TM506 500-series 6-slot Power Module	\$250.00
TEK TM515 500-series 5-slot Traveller Power Module	\$275.00

Introducing the Video Communication Terminal

**Compatible with Jerrold,
Scientific Atlanta
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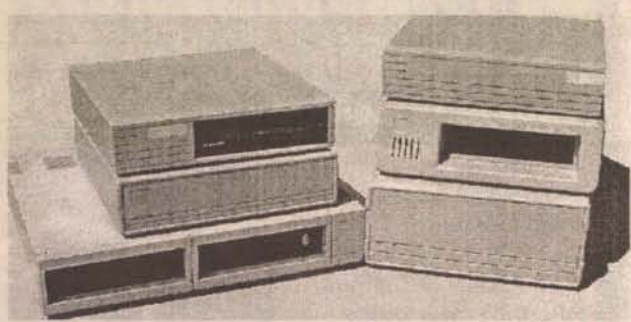
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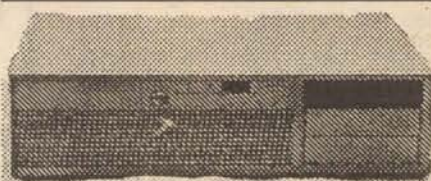
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THIS LOW circuit loading SCOPE PROBE produces a 60dB **SPECTRUM ANALYZER** display on your inexpensive scope. Excellent EMI/compliance tool. Request Technical Tips for line conduction, field strength, and current probe. 255 Spectrum Probe 30KHz to 2.5MHz \$279. 107 Probe 1 to 100 MHz \$249 (\$279 extra shielding). Accessory Current Adapters: IA5 \$19, IA7 \$29. **SMITH DESIGN**, 215-661-9107, 207 E. Prospect Ave., N. Wales, PA 19454.

LOGIC ANALYZER 64 bit TTL analyzer Max sample rate 40MHz 32K trace buffer. Powerful 64 bit comparator circuit for triggering or compare store. Four trigger levels. Works off PC printer port. Data displayed on PC or laptop screen. Compact, portable measures 7¼"x11"x1½". \$950. For information contact DataTrace, Inc., 404-394-5918, FAX: 404-394-0199.

WANTED: LATE model test equipment & manuals. Naptech buys & sells test equipment by HP, Tektronix, etc. Wanted: Tek 2200 and 2400 series, HP 8560 & 8590 series, Fluke 87, 77, 97, 8050A, etc. Wanted: HP, Tektronix, Fluke, etc. catalogs & manuals. Wanted: Source for HP, Tektronix, etc. parts. Call Naptech, 707-928-1961.



FULL SPECTRUM ELECTROMAGNETIC METER. New TriField meter independently reads AC electric fields, AC magnetic fields and RF/microwave power density. Makes a variety of field measurements: **Magnetic setting** (.2-100 milligauss at 60Hz) measures magnetic background, ground faults, high-field equipment, and can identify which wire of a group is carrying AC current. **Electric setting** (.5-100 kV/m at 60Hz) detects improper grounding, fields around high voltage equipment, VDTs, and fluorescent lights, and can distinguish hot v.s. ground wires by proximity. **RF/microwave setting** (50MHz to 3GHz, .01 to 1 mW/sq.cm) measures antenna radiation patterns, leaky microwave ovens, etc. The TriField meter is an analog-type with 3 scales, 9V transistor battery included. Electric & magnetic are **omni-directional**. 1 year warranty. \$145. Price includes delivery. AlphaLab, Inc., 1280 South 300 West, Salt Lake City, UT 84101. Call for free literature on health effects of electromagnetic fields. 1-800-POWERLINE (769-3754).

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Nuts & Volts Magazine/November 1994 69

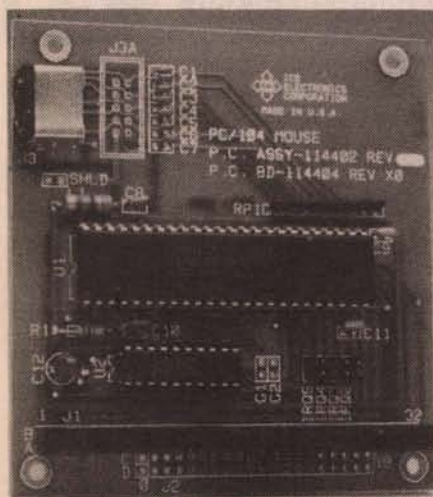
New Product

Our readers are always looking for new and interesting electronic items. Showcase your NEW PRODUCTS here to help stimulate your product's success. Submit all news releases, product information, and/or photos to:

NUTS & VOLTS MAGAZINE
NEW PRODUCT EDITOR,
430 PRINCELAND CT., CORONA, CA 91719

News

BUS MOUSE BOARD



ICS Electronics announces a new Bus Mouse Board in the small PC/104 form factor. Featuring a Logitech three-button mouse and driver, ICS's new PC/104 Mouse Board allows the addition of a mouse to any PC/104 style embedded computer without sacrificing a serial port or creating IRQ conflicts.

The model PC/104 Mouse is similar to a bus mouse card for a PC except that it's packaged on the PC/104's 3.55 x 3.77 inch board size. The PC/104 Mouse Board plugs into any PC-104 card stack. On-board jumpers allow selection of IRQ levels two through five. The board includes a nine-pin mini-DIN connector for direct connection to a three-button mouse. A nine-pin header is also provided on the board in case the user wants to locate the mini-DIN connector in another location.

The PC/104 Mouse Board is shipped with a three-button Bus Mouse and a copy of the Logitech mouse driver. The unit price of the PC/104 Mouse is \$150.00 each.

For more information, contact:

ICS
473 LOS COCHES ST., DEPT. NV
MILPITAS, CA 95035
408-263-5500

ILLUSTRATED ENCYCLOPEDIA OF ROBOTICS AND ARTIFICIAL INTELLIGENCE

McGraw-Hill introduces *The McGraw-Hill Illustrated Encyclopedia of Robotics and Artificial Intelligence*. Electronics author Stan Gibilisco addresses the need for an easy-to-use, broad view reference book about these fascinating and

important topics.

Written in a style understandable to the average high school science student, this book covers far-reaching, sophisticated technologies in a way that will provoke and hold the interest of hobbyists and young scientists-to-be. No high-level mathematics or unnecessary technical jargon will be found here.

Packed with more than 500 alphabetically arranged articles, 400 illustrations, and extensive cross-referencing, this unique resource makes it easy to find the latest facts on a wide range of subjects involving robotics and artificial intelligence.

Gibilisco covers such intriguing subjects as robotic space probes, military uses of robots, robots and artificial intelligence in medicine, robots and automation, robotics and security, and reliability factors in robotics and artificial intelligence. The book also includes an extensive index to help the reader quickly locate information.

For more information, contact:

TAB BOOKS/MCGRAW-HILL, INC.
DEPT. NV
BLUE RIDGE SUMMIT, PA 17294
717-794-2191
FAX: 717-794-2103

CLASSIC CLOCK



Amateur Radio Excellence Products introduces the ARE Classic Clock.

The Amateur Radio Excellence "Classic" are 100% crafted in the USA and features a 12- and 24-hour dial, quartz accuracy, and fully laminated artwork face with the call letters of your choice custom-printed with the artwork. The clock frame measures approximately 9" square by 2" deep and is suitable for desk-top display or wall mounting.

The ARE Classic Clock is pow-

ered by one AA battery, which is included. Every clock is shipped in its own gift box, packed in fine tissue. The dial face is designed in dark brown on light beige, for an heirloom finish. Frames are available in simulated light oak, walnut, or black finishes.

The clock costs \$39.99 plus \$4.50 shipping within the United States.

For more information, contact:

AMATEUR RADIO EXCELLENCE PRODUCTS
P.O. BOX 1551, DEPT. NV
MANCHESTER, NH 03105

SYNTHESIZED AMATEUR RADIO RIG KIT



S & S Engineering is now offering the ARK4, a low cost synthesized amateur radio rig. It's small and portable, easy-to-build, with top quality components.

The model is available in several versions, so you can buy as little or as much as you need. Kit prices start at only \$99.95 for the Synthesized Transmitter, with a full transceiver (including case) for \$199.95. The ARK4 Transceiver including all options and case is also available assembled for \$269.95.

The ARK4 is one board and requires no wiring. It tunes in 1 KHz steps synthesized, and finer steps are crystal controlled with no drift. You can accurately tune the entire 40 meter CW band.

Power out is 3-4 watts at +12V. The kit contains a MIL quality, glass-epoxy, fully silkscreened PCB and all component parts to assemble whichever version of the ARK4 you desire. Once again, all coils and transformers are prewound.

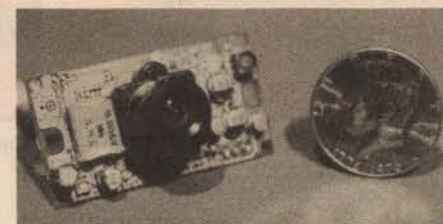
The ARK4 Transmitter is synthesized using a PLL design and has a built-in TR switch. The receiver is a Superhet single signal design. The transceiver features full QSK, sinewave sidetone, and immediate recovery AGC. The fine tune is crystal controlled and the control has detents so frequencies are repeatable. The RIT Option tunes $\pm 600\text{Hz}$. The case is steel and

extruded aluminum with silkscreened front & rear panels. Case dimensions are 5.5" x 1.5" x 7.5" (W X H X D). The Keyer uses the Curtis chip and is designed right into the PCB. Dimensions of the PCB are 5.26" x 7.18". A fully built unit (all possible options), including the case, weighs only 25 ounces.

For more information, write or call:

S & S ENGINEERING
14102 BROWN RD., DEPT. NV
SMITHSBURG, MD 21783
301-416-0661
FAX: 301-416-0963

VIDEO TOYVISION



Supercircuits now has available a tiny video camera, ideal for live video telemetry.

The Supercircuits PC-10SX microvideo camera weighs just 1 ounce, produces a sharp 380 lines resolution, and works in light as low as 1 lux, with automatic exposure control. Output is standard NTSC composite video and it runs on 10-13.5 volts DC, drawing only 100 milliamps.

Tiny size and compact board layout make it especially suited to robotic and "toyvision" amateur TV installations. The PC-10SX mounts easily in R/C cars, planes, or underneath helicopters.

For further details, write or call:

SUPERCIRCUITS
13552 RESEARCH BLVD., DEPT. NV
AUSTIN, TX 78750
512-335-9777
FAX: 512-335-1925

2950A QUARTZ FREQUENCY STANDARD



Novatech Instruments, Inc., is now offering the Model 2950A Quartz Frequency Standard with simultaneous sinewave outputs of 5 MHz, 1 MHz, and 100 KHz. Starting at \$995.00.

The 2950A is offered in three accuracy grades to provide stability of up to 5×10^{-11} per day. The three accuracy grades are the 2950A-01 with $< 1 \times 10^{-9}$ daily aging for \$995.00, the 2950A-02 with $< 1 \times 10^{-10}$ daily aging for \$1,395.00, and the 2950A-03 with $< 5 \times 10^{-11}$ daily aging for \$1,995.00.

Other features include spectral

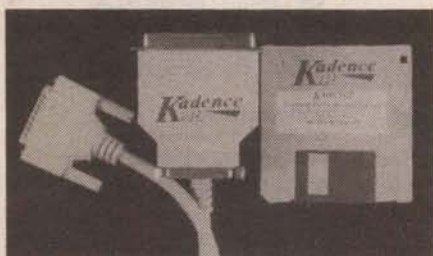
New Product News

purity with harmonic outputs down <-40 dBc and spurious non-harmonic outputs down <-70 dBc; low phase noise, -152 dBc/Hz at 100 Hz offset for the 2950A-03 as an example; the ability to drive up to five 50 ohm loads from the 5 MHz output; an internal rechargeable battery with over two hours of standby power; and an input for voltage control of the fine frequency adjustment for those who want to lock the 2950A to a primary standard.

For more information contact:

NOVATECH INSTRUMENTS, INC.
1530 EASTLAKE AVE. E., #303,
DEPT. NV
SEATTLE, WA 98102
206-328-6902
FAX: 206-328-6904

SMART CABLE CONTROLS SEVEN SCSI DEVICES



Kadenace Systems is now offering an integrated cable which allows you to add up to seven SCSI devices from your PC's parallel printer port and still use the printer at the same time.

Easy to install, the SCSIlite II comes with MSDOS software that automatically adapts itself to the port you are using. No switches, no jumpers to set, no batteries, nor power supplies are needed.

You can control external CD-ROM's, hard disk drives, tape drives, magneto-optical drives, and other SCSI peripherals. Software drivers, including audio playing software (Musik_Maker) and tape back-up and restore software (Tapestar) are included with the package.

Complete auto install software is provided.

Transfer rates are: Model 550 up to 260KB/sec; and Model 450 up to 150KB/sec.

For further details, contact:

KADENCE SYSTEMS CO.
28195 LETICIA, DEPT. NV
MISSION VIEJO, CA 92692
Phone/FAX 714-544-7608

VIDEO TRIAXIAL CABLES



Nemat Electronics International has introduced a new line of extra flexible video triaxial cables for indoor and outdoor use.

The cables are available in both 3/8" (.360 OD) as well as 1/2" (.520 OD) sizes, and in a wide variety of colors.

Nemat offers these cables either in bulk reels or fully terminated and tested.

These cables are suitable for use in temperatures as low as -60°C and are resistant to oils, chemicals, and ultraviolet light.

Both cables are compatible with standard Kings triax connectors.

For more information, contact:

NEMAT ELECTRONICS INTERNATIONAL, INC.
12240 N.E. 14TH AVE., DEPT. NV
NORTH MIAMI, FL 33161
305-899-0900
FAX: 305-895-8178

DOUBLE BRAID ULTRA VIOLET RESISTANT ROPE

Davis RF Co. now has available a military type Dupont, double braided Dacron®, ultraviolet resistant rope for use in supporting wire antennas, antenna supports, vertical antennas/supports, towers, general antenna erection/installations, and gin poles, etc.

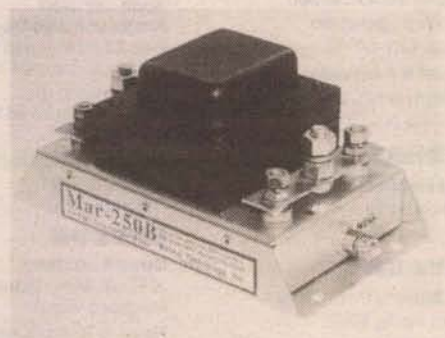
This highly stretch-resistant Dacron is preferable to nylon rope which will stretch and can become dangerous in terms of elastic lash back upon breaking.

The Davis RF product is a double braid rendering greater strength and UV resistance. It is available in three sizes: 3/32" (255+ lbs. strength); 3/16" (765+ lbs.); and 5/16" (1,765+ lbs.). Cost is 6, 11, and 16 cents per foot, respectively, sold in increment lengths of 50 feet up to 3,000 ft continuous (3/32"); 1,000 ft continuous (3/16"); and 500 ft continuous (5/16").

For more information, contact:

DAVIS RF CO.
P.O. BOX 230, DEPT. NV
CARLISLE, MA 01741
508-371-1356
FAX: 508-369-3484

250 AMP ALTERNATOR NOISE FILTER



Marine Technology, Inc., has developed the MAR-250A filter — a powerful alternator noise filter which will handle 250 amps continu-

ously (350 amps intermittent duty), and is designed for all 6 to 32 volt DC negative-grounded systems.

The MAR-250A will eliminate alternator whine and signal interference to communications and navigation equipment such as: commercial AM/FM/SSB/VHF radiotelephone equipment; public address systems; DC to AC inverter systems; and Loran-C navigation equipment.

The MAR-250A is 4 1/4" wide, 9 1/2" long and 3 1/2" high and weighs 6 1/2 lbs. The suggested retail price is \$219.95.

For additional information about alternator filters and electrical interference problems, contact:

MARINE TECHNOLOGY, INC.
2667 E. 28TH ST. #505, DEPT. NV
SIGNAL HILL, CA 90806
1-800-772-0796
FAX: 310-427-0770

ETHERNET PRINT SERVER



Agile has announced the 4550 AE/PS™, a stand-alone pocket-sized network print server for the Ethernet environment.

Its multiple protocol support enables users to print from Novell NetWare and LAN Manager/LAN Server simultaneously to a parallel-attached network printer.

Upgrades to Apple EtherTalk and TCP/IP are available with a software key, enabling simultaneous printing from all four protocols. Whether the user is running PC, UNIX or Macintosh systems, the 4530 E/PS provides seamless connectivity to a printer in an Ethernet LAN environment.

With its powerful built-in features, the Agile 4530 E/PS is easy to install and use. It is physically attached to the network via 10baseT (twisted pair) cabling. With its small size, it plugs directly into the printer's parallel port. RISC-based, state-of-the-art technology gives it its speed, rated at 1200 Kbps, enabling users to take full advantage of their printer's potential.

Other features include up to eight logical printers, password security, bi-directional communications, automatic protocol sensing, and statistics logging. The 4530 E/PS is SNMP-MIB/II compliant for network resources management.

The Agile 4530 E/PS is backed by a full two-year warranty and is available for \$395.00 with quantity

and VAR prices also available. For further details, contact:

AGILE
825 ALFRED NOBEL DR., DEPT. NV
HERCULES, CA 94547-1899
510-724-1600
1-800-538-1634
FAX: 510-724-9624

DANCER ARM POSITION CONTROLLER



A new electronic dancer arm position controller which provides constant loop control without the use of a potentiometer and the associated mechanical problems and downtime has been introduced by Waddington Electronics, Inc.

The Super Dancer is an electronic arm position controller that features circuitry which allows zero to full speed set points, adjustable for the full 180° range of the arm, depending upon loop heights and application. Eliminating potentiometers and the associated wear and tear and downtime, this dancer arm controller automatically integrates to achieve minimum loop height changes.

Preventing damage to coil stock and the uneven rewinding that can be caused by frequent starting and stopping, the Super Dancer electronic arm position controller permits speed adjustments while the equipment is operating. Options include top and bottom limit or alarm relays to control tightness, line speed summing, and AC or DC drive controls as a complete turn-key system package.

The Super Dancer electronic arm position controller is priced from \$625.00 (list).

For more information, contact:

WADDINGTON ELECTRONICS, INC.
25 WEBB ST., DEPT. NV
CRANSTON, RI 02920
401-781-3904
FAX: 401-781-1650

ALABAMA

Alabama Radio
8907 Alabama Highway 9
Anniston 36201

ARIZONA

Electronic Materials & Computers — Phoenix
3102 W. Thomas Rd. #902
Phoenix 85017

Electronic Materials & Computers — Scottsdale
10637 N. 71st Way
Scottsdale 85254

Lynntronics
3415 W. Glendale Ave. #4
Phoenix 85051

TRI-TEK
9014 N. 23rd Ave. #11
Phoenix 85021

Wholesale Satellite
706 E. Fort Lowell Road
Tucson 85719

CALIFORNIA

A & A Engineering
2521 W. La Palma #K
Anaheim 92801

ABC Electronics
1210 S. Garey Avenue
Pomona 91766

All Electronics
905 S. Vermont Avenue
Los Angeles 90006

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14928 Oxnard Street
Van Nuys 91411

Alltronics
2300-D Zanker Road
San Jose 95131

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3805 Ocean View Boulevard
Montrose 91020

Collins Computer Innovations
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426 W. Taft Avenue
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3537 Old Conejo Road #115
Newbury Park 91320

Computing Technology
251 Balsam Street
Ridgecrest 93555

Corporate Systems Center
1294 Hammerwood Avenue
Sunnyvale 94089

Darcell
4910 Santa Anita
El Monte 91732

Electronic Material Industries
10153½ Riverside Drive #194
Toluca Lake 91602

Ford Electronics
8431 Commonwealth Avenue
Buena Park 90621

Henry Radio, Inc.
2050 S. Bundy Drive
Los Angeles 90025

Hi-Fi Doctor
1814 E. Ball Road
Anaheim 92805

House of Phones
11220 Talbert Avenue
Fountain Valley 92708

HSC Electronic Supply of Sacramento
4837 Amber Lane
Sacramento 95841

HSC Electronic Supply of Santa Clara
3500 Ryder Street
Santa Clara 95051

HSC Electronic Supply of Santa Rosa
6819 Redwood Drive
Cotati 94931

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401 N. Johnson Avenue
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Oroville 95965

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8895 Laurel Canyon Boulevard
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100 E. Orangethorpe Avenue
Anaheim 92801

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21021-504 Soledad Canyon Road
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4020-C California Avenue
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13225 Harbor Boulevard
Garden Grove 92643

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535 Salmar Avenue Suite D
Campbell 95008

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11106 Magnolia Boulevard
North Hollywood 91601

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11550 Zelzah Avenue
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Vancouver, BC V5X 3L2

RP Electronic Components
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Vancouver, BC V6K 1N7

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Denver 80220

International Tesla Society
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Colorado Springs 80909

Western Test Systems
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Broomfield 80020

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Hamden 06517

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Enfield 06082

FLORIDA

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1502 S. State Road 7
Hollywood 33023

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Lehigh Acres 33971

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Fort Lauderdale 33301

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Fort Pierce 34982

J.T. Communication
579 NE 44th Avenue
Ocala 32671

Mike's Electronic Distributing Co.
1001 NW 52 Street
Fort Lauderdale 33309

Skycraft Parts & Surplus, Inc.
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Winter Park 32789

Sunnys At Sunset
8260 Sunset Strip
Sunrise 33322

Tinker's Workshop
3207 13th Street
Saint Cloud 34769

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Omar Electronics
2130 Highway 81 SW
Loganville 30249

IDAHO

RJM Electronics, Inc.
4204 Overland Road
Boise 83705

The Current Source
5159 Glenwood
Boise 83714

ILLINOIS

NUTRON Computers & Electronics, Inc.
821 E. Roosevelt
Lombard 60148

Pick's Electronics
Lewis Park Mall
Carbondale 62901

INDIANA

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7399 N. Shadeland Ave. #152
Indianapolis 46250

New Horizons
Corner of SR 26 & SR 55
Pine Village 47975

SHF Microwave Parts
7102 West 500 South
La Porte 46350

KANSAS

Lloyd's Radio & Electronic, Inc.
220 W. Harry Street
Wichita 67213

Revcom Electronics
1104 S. Main
Scott City 67871

KENTUCKY

Security World Plus
212 Pike Street
Covington 41011

MARYLAND

Maryland Radio Center
8576 Laureldale Drive
Laurel 20707

MASSACHUSETTS

BNF Enterprises
119 Foster Street
Peabody 01960

Eastbridge Electronics
49 Cedar Street
East Bridgewater 02333

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Hai-Tronix, Inc.
12671 Dix-Toledo Highway
Southgate 48195

Little Professors Book Center
22174 Michigan Avenue
Dearborn 48124

Purchase Radio Supply, Inc.
327 East Hoover Avenue
Ann Arbor 48104

MINNESOTA

Satellite City
2663 County Road 1
Moundsview 55112

MISSOURI

Accurate Instruments
3123 Weatherford Road
Independence 64055

Electronics Exchange
8644 St. Charles Rock Road
St. Louis 63114

Independence Electronics
119 S. Main
Independence 64050

Missouri Radio Center
630 NW Englewood
Kansas City 64118

Stewart & Associates
244 Mid River Center #200
St. Peters 63376

NEBRASKA

Ladd Electronics Co.
111 N. 41st Street
Omaha 68131

NEVADA

Less Buster's Electronics
Broad Acres Mall
2930 N. Las Vegas Blvd. #VSTG-22
North Las Vegas 89030

NEW HAMPSHIRE

Radio World
1656 Nevada Highway
Boulder City 89005

NEW HAMPSHIRE

Cahill Electronics
160 Main Street
Kingston Plaza
Kingston 03848

Electronic Orphanage
97 Eddy Road
Manchester 03102

NEW JERSEY

JR Tech Systems
1309 Route 71
Belmar 07719

NEW MEXICO

Consumertronics
2011 Crescent Drive
Alamogordo 88310

Vonns Electronics Co.
1306 East Madrid
Las Cruces 88001

NEW YORK

All Phase Video Security, Inc.
70 Cain Drive
Brentwood 11717

Audio-Video Exchange MS Associates
615 S. Main Street
North Syracuse 13212

GS & E
182 Avenue D
Rochester 14621

Hirsch Sales Co.
219 California Drive
Amherst 14221

Tony's Equipment
10065 Morley Road
North Collins 14111

VHF Communications
453 Buffalo Street
Jamestown 14701

NORTH CAROLINA

North State Tech Services
4608-M Industry Lane
Durham 27713

OHIO

Mike's Surplus Stuff
132½ E. 3rd Street
Dayton 45402

Bigelow Electronics
186 E. Jefferson Street
Bluffton 45817

Compustuff
2751 Medina Road
Medina 44258

Computer Keyways
611 S. Main Street
Miamisburg 45342

Computers & Engineering
519 Bailey Street
Hamilton 45011

Digital One
7601 Mentor Avenue
Mentor 44060

Footsteps
4925 Jackman Road Store #58
Toledo 43613

Hosfelt Electronics, Inc.
2700 Sunset Boulevard
Steubenville 43952

Innovative Ideas
962 Kenmore Boulevard
Akron 44314

Leo's Book Shop
330 North Superior Street
Toledo 43604

Mendelson Electronics
340 E. 1st Street
Dayton 45402

North Olmsted Amateur Radio Depot
29462 Lorain Road
North Olmsted 44070

Powermaxx, Inc.
1587 U.S. Route 68 North
Xenia 45385

The Electronics Exchange, Inc.
547 McKinley
Akron 44311

OREGON

News & Smokes
2295 W. Main Street
Medford 97501

News & Smokes #8
259-C Barnett Road
Medford 97501

Norvac Electronics
7940 SW Nimbus Ave. Bldg. 8
Beaverton 97005

Portland Radio Supply
234 SE Grand Avenue
Portland 97214

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33 NW Park
Portland 97209

PENNSYLVANIA

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East Stroudsburg 18301

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Lehman Scientific
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Harrisburg 17103

Surplus AI
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Hunlock Creek 18621

The Insideoutlet
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Norristown 19401

PUERTO RICO

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Calle 6 #13, Ext. San Agustin
Rio Piedras 00926

SOUTH CAROLINA

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Columbia 29203

ASA
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Myrtle Beach 29577

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Route 1 Box 195 Highway 6
Cross 29461

R&D Associates
514½ West Avenue
North Augusta 29841

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GBC Electronics
125 Birch Street
Blountville 37617

TEXAS

Tanner Electronics
1301 W. Beltline #105
Carrollton 75006

Tucker Surplus Store
1805 Reserve Street
Garland 75042

UTAH

Omega Electronics
1500 North 150 West
Provo 84604

VIRGINIA

Electronic Equipment Bank
516 Mill Street
Vienna 22180

Riley's Distributing
1045 Edom Road
Harrisonburg 22801

Satellite Headquarters
9310 Timberlake Road
Lynchburg 24502

WASHINGTON

A-B-C Communications, Inc.
17550 15th Avenue NE
Seattle 98155

Amateur Radio Supply Co.
5963 Corson Avenue S. #140
Seattle 98108

Supertronix
18650 68th Avenue South
Kent 98032

WEST VIRGINIA

IBIM-Colorsat
Route 1 Box 113
Morgantown 26505

WISCONSIN

Amateur Electronic Supply, Inc.
5710 W. Good Hope Road
Milwaukee 53223

Cudahy News & Hobby Center, Inc.
4758 Packard Avenue
Cudahy 53110

E.H. Yost & Co.
7344 Tetiva Road
Sauk City 53583

Rich's Surplus
Route 2 Highway H North
Stanley 54768-9418

PRIME ELECTRONIC COMPONENTS, INC.

150 West Industry Court, Deer Park, NY 11729

516-254-0101 •

FAX 516-242-8995



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2732.....\$0.75 Ea.	27C128A.....\$1.75 Ea.
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CLOSING DATE FOR NEXT ISSUE NOVEMBER 10TH

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85

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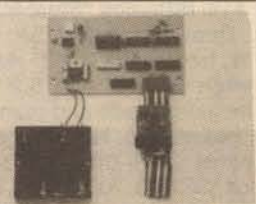
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500 Channels • 20 banks • Alphanumeric display
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Frequency step resolution 5, 12.5, 25 & 50 KHz.
Size: 10-1/2" Wide x 7-1/2" Deep x 3-3/8" High
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54,000 - 71,995 MHz. (WFM), 72,000 - 75,995 MHz. (NFM),
76,000 - 107,995 MHz. (WFM), 108,000 - 136,995 MHz. (AM),
137,000 - 173,995 MHz. (NFM), 174,000 - 215,995 MHz. (WFM),
216,000 - 224,995 MHz. (NFM), 225,000 - 399,995 MHz. (AM),
400,000 - 511,995 MHz. (NFM), 512,000 - 549,995 MHz. (WFM),
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Weather Stations

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The Weather Monitor II (7440-K) comes complete with anemometer with 40 feet of cable, external temperature sensor with 25 feet of cable, junction box with 8 feet of cable, AC power adapter, detailed instruction booklet and one year limited factory warranty.

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Questions & Answers

TECH FORUM

This is a READER TO READER Column. All questions AND answers will be provided by *Nuts & Volts* readers and are intended to promote the exchange of ideas and provide assistance for solving problems of a technical nature. All questions submitted are subject to editing and will be published on a space available basis if deemed suitable to the publisher. All answers are submitted by readers and *NO GUARANTEES WHATSOEVER* are made by the publisher. The implementation of any answer printed in this column may require varying degrees of technical experience and should only be attempted by qualified individuals. Always use common sense and good judgement!

QUESTIONS

The Precision Fidelity C-8A pre-amp is noisy in phono mode. Any ideas? White noise?

10941 Gary Nachman
Wauconda, IL

To install an additional 110V outlet between two existing outlets, I need to locate the wires in the wall. Passing a 5 amp direct current through the wires and using a sensitive compass to detect the magnetic field didn't work. A low cost version of an Amprobe or Greenlee circuit tracer is what I need.

10942 Richard Nadel
Cherry Hill, NJ

How do you retard timing electronically on '78 to '87 Chevy, Ford autos and vans? There are timing lights with controls (Pot.) that do this.

10943 Anonymous

I have a need to transfer my edited VHS NTSC video tapes to the SECAM system. Until now, I have not been able to find a way to do it. I own the following equipment: Sharp Camcorder Model VL-C77UA, Ser.# 315322; TMK VHS VCR Model 1030, Ser.# 21107163; and a GE VHS VCR Model 1CVD5021X, Ser.# 6T4R51000. I would like to find out what it takes to make this kind of transfer.

10944 Marcel G. Collin
Long Beach, CA

Currently, I have a 286 computer running DOS 3.3. However, I have many old files on 5-1/4" CP/M format disks (specifically, Kaypro II and 2). I am looking for software which will run on DOS 3.3, and will convert my CP/M files. I have both 3-1/2" and 5-1/4" drives on my 286. By the way, both of my Kaypros have dead "B" drives.

10945 Tom Tronzo
New York, NY

I have a Yaesu FT-890 HF transceiver which will transmit only on amateur bands. I wish to modify this radio so that it will transmit on any frequency, especially the 11 meter band. Does anyone have directions for this mod., or does any recent mod. book have this radio listed?

10946 John Wolfe
Norfolk, NY

In a recent issue of *Nuts & Volts* (Aug. '94) there is an interesting article on surround sound, but I have graduated to the Dolby pro-logic. The equipment that I purchased doesn't quite meet the quality that I would like. Is

there anyone out there who knows how the pro-logic works and has some circuits that I could build at home?

10947 Harvey Hunt
Templeton, CA

I own a NEC Multi-Speed Laptop computer that has two unused memory sockets in the bottom compartment next to the built-in application ROMS. How can I load programs into EPROMs and access them as a non-volatile ROM drive under MS-DOS? How do I get DOS to recognize the drive? Do I need to run EXE2BIN on my applications and use a linker to relocate the binary files to a specific address? Where do the DIR and FAT tables go and how do I create them?

10948 Ryan Crowe
Spokane, WA

I am looking for a design for a portable short range transmitter at the AM band intermediate frequency and the FM band intermediate frequency. Is this feasible?

10949 Clayton Robson
Vida, OR

I like to build my own projects from scratch. My hobby is amateur radio, but I have always had an interest in radiation.

What I am looking for is a device I could build that could display radiation levels. It would be nice if it had a digital display, but an analog meter would be okay, and maybe an audible tone.

I would like this device to be a desktop unit, so it wouldn't need batteries. I would think that with all the new advances in electronics, that some solid-state device has replaced the old Geiger counter tube.

109410 Doug Dykstra
Grand Rapids, MI

I need an efficient programmer to develop software for the microchip PIC 16C54 and 16C57 controllers.

109411 Bill Sanders
Albany, GA

I am having trouble determining the shunt to use on the variable 3 amp 0-30VDC power supply I built. Is there a formula for determining the shunt value? I have already "pegged" two amp meters by using the trial and error method.

109412 Raymond Zambrana
S. Pasadena, CA

We have call return on our phone, but would like to know the telephone number of the calling party. Is there a kit on the market which will permit a LCD or some other form of readout?

109413 Robert Grover
San Jose, CA

What about the Hubble? Why can't everyone see it or download info?

109414 Anonymous

Does a transformer transform voltage by a turns ratio or by the ratio of secondary and primary inductances?

109415 Anonymous

I have five Wang motherboards that I want to make a bastard system with for hobby use. I am an electronics student and hobbyist. I want to make a multi-processor with them. The board part numbers are 210-8274A-R2M3, 210-8267-B-R2M2, and 210-8490-A-ROM. Master/slave configuration. I also have a Cipher Dibble 1 tape controller part number A 2002 8660-002. I need specs and schematics for these boards. I also have a Xerox Corp. (8086) XT Split Back Plane.

Any suggestions/board upgrade. Can tape controller work with Bernoulli 10 drives?

109416 David Schwartz
Colonia, NJ

I have two weather satellite antennas, 137.5MHz. I need information regarding an automatic switcher that will select the stronger signal and feed it to the receiver.

109417 Charles R. Stone
St. Charles, IL

How can I prevent the alternator/stator windings on my turbo-charged motorcycle, which overheats, from failing every 20K miles? It is then necessary to drop the engine and remove the rear cover from the engine in order to replace the stator; a very time-consuming and expensive operation. I have several mechanical solutions offered, but I would appreciate any of your readers' electronic solutions.

Most of the use of the cycle is highway touring, which boils the battery dry in about 5K miles, so I feel sure that there is excess output capacity from the alternator.

109418 Robert Davis
Vancouver, WA

Recently, I purchased a Rolmphone Model #61000 and 64000 at an auction. Is it possible to buy a converter or an adapter so the phone can work on an analog telephone line?

109419 Jan Gnyp
Syracuse, NY

I need a circuit that will disconnect a battery (24V) when it is discharged below 22V and reconnects when charging voltage is re-applied. Charging is supplied by power supply

ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
- Payment of \$25.00 will be paid within four weeks of publication if your answer is printed.
- Only one answer per question will be printed.
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- Due to space limitations, we can not reprint the original questions with the answer. The question number and the issue it appeared in are printed above the answer.
- Unanswered questions from a past issue may still be responded to.

QUESTION INFO TO BE CONSIDERED FOR PUBLICATION

All questions should relate to one or more of the following:

- 1) Circuit Design
- 2) Electronic Theory
- 3) Problem Solving
- 4) Other Similar Topics

INFORMATION/RESTRICTIONS

- No questions will be accepted that offer equipment for sale or equipment wanted to buy.
- Selected questions will be printed one time on a space available basis.
- Questions may be subject to editing.

HELPFUL HINTS

- Be brief but include all pertinent information. If no one knows what you're asking, you won't get any response (and we probably won't print it either).
- Write legibly (or type). If we can't read it, we'll throw it away.
- Include your Name, Address and Phone Number. Only your name will be published with the question, but we may need to contact you.

located 600' away from aux battery pack. So circuit should be local and operate from power bus.

109420 D.W. Moore
Medina, NY

How do I go about anodizing aluminum sheets, and what colors are available besides black?

What do I need to electroplate with aluminum? I have the power supply, but how high of an ampere becomes unsafe or overkill?

109421 Wayne Chesser
Sandy, UT

I need the pin-out and other information for the 325572-01 chip used in the Commodore 1541 disk drive. Also, where can I purchase these chips?

I would also like to know how to interface 2 Commodore 64s.
109422 Robert W. Ritchey
Vandalia, IL

ANSWERS

ANSWER TO #11944 - OCT. 1994

The LM317 adjustable voltage regulator IC comes in three popular types of packages. One is a power transistor type package (TO-3) identified with a "K" suffix and shown in Figure 1. Another is the plastic power tab (TO-220) identified with a "T" suffix as shown in Figure 2. The third is a small metal can (TO-39) package identified with the "H" suffix and is shown in Figure 3. Lead identification for all of the packages is indicated on the respective diagrams.

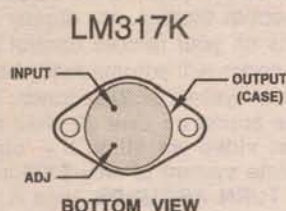


Figure 1

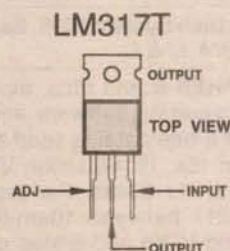


Figure 2

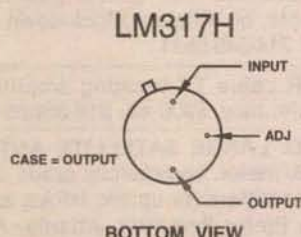


Figure 3

I'm certain that you already know how to hook-up the regulator; however, for those who may not, Figure 4 shows a typical simplified wiring diagram. Note that the output voltage is determined by the two resistors R1 and R2 (the value of R2 is recommended to be around 240 ohms). The regulated output voltage is given by the formula:

$$V_{OUT} = 1.25 \left(1 + \frac{R_2}{R_1} \right)$$

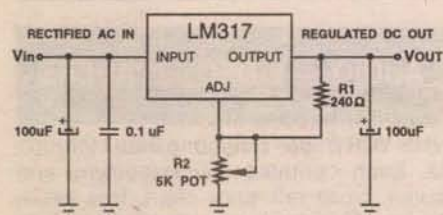


Figure 4

The output current can be determined by measuring the voltage drop

across a stable, precision resistance (shunt) placed anywhere in series with the load. As shown in Figure 5, the voltage across the shunt (R_s) will be determined by the current flowing through it (which is the same current flowing through the load) and can be determined from ohms law to be equal to $R_s \cdot I_L$.

Thus, the current to the load is found by measuring the voltage drop across R_s and dividing by the value of R_s .

There are several factors involved in selecting the value of R_s . First, it is important to make R_s small (0.01-0.001 ohms) in order not to reduce the supplied voltage to the load. For example, a 1 ohm shunt would drop an entire volt across itself when 1 amp flowed through it.

A serious consequence of this is that as the load current varies from zero to maximum (1.5A for the LM317), the voltage dropped by the shunt would change causing the load voltage to fluctuate. This undermines the whole point of developing a regulated voltage at the output. Using lower values for R_s reduces this effect. For example, for $R_s = 0.01$ ohms, the maximum voltage deviation will be 15 millivolts and may be acceptable. Also, for this resistance, the current to the load will be 100 times the measured voltage drop.

Another issue which directly follows from this is that the voltage drop across R_s will be very small for small values of R_s . In our example of $R_s = 0.01$ ohms, the voltage will vary from 0 to 15 millivolts as the current ranges from 0 to 1.5 amps. If we want to measure current down to the milliamp, we will need a voltmeter capable of resolving voltage differences down to 10 microvolts (each change of 10 microvolts will represent a change of 1 mA). Lower values of R_s require more sensitive voltmeters.

A third issue is the power rating of the shunt. Since power is determined by the square of the current times the

resistance, our 0.01 ohm shunt will need a power rating of $(1.5)(1.5)(0.01) = 22.5$ milliwatts which is not a problem. If, however, a 1 ohm shunt were used, then a 2.25 watt (minimum) power rating would be needed. Since the power rating goes up as the square of the current, this quickly becomes a problem for high current supplies and explains the reason why shunts are usually substantial pieces of metal with high power ratings and low resistance.

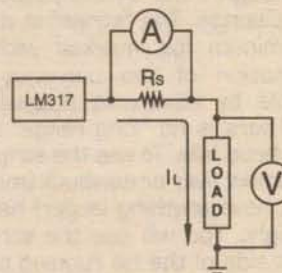


Figure 5

Jay Rabkin
Pasadena, CA

ANSWER TO #11942 - SEPT. 1994

What you need is a "disassembler" or "unassembler" to convert from the machine instructions stored in the 2716 EPROM back into assembler mnemonics which you can read. For example, the DEBUG command available on IBM-PCs has a "U" command for unassembling instructions back into 80x86 assembly code.

The disassembler which you require will obviously depend on which microprocessor is running the code stored in your 2716 EPROM. If the original source code was written at a higher level than assembly code (C, FORTRAN, Pascal, etc.) then the task becomes more difficult since there are many different ways of writing software which can compile into the same machine instructions.

There are software programs which attempt to "uncompile" machine code into one possible version of the

original source code used to generate it. Such programs may also generate flow chart type outputs which may not look anything like your original code. The best places to look for these programs are on university bulletin boards and they are usually free.

Also, any comments which you may have written as part of the source code will be irretrievably lost since they were not saved in the 2716 EPROM. Note, since the 2716 can only save 3048 bytes, you may want to consider disassembling it by hand. The exercise might also refresh your memory about how the program works. Of course, before any of this can begin, you must dump the contents of the EPROM to a file. Any PROM programmer connected to a PC will be able to do this once you select the 2716 part from its device menu.

Jay Rabkin
Pasadena, CA

ANSWER TO #9948 - SEP. 1994

An RJ-45 connector is a connector that is growing in use. It is used quite often in Local Area Networks in a variety of different pin-out configurations. An RJ-45 is simply an eight conductor modular plug or jack. All the pins may or may not be used.

Unless you are dealing with level 4 or 5 cable (100+ MHz capability) you can usually spot most problems using a simple volt-ohmmeter. Here is how to do it:

1. Disconnect both ends of the cable run in question. Disconnect cable at the concentrator for quite often problems are in the patch cords.

2. Make up an RJ-45 test jack by shorting all the conductors of a jack together.

3. Plug the cable at the terminal into this shorted test jack and go to the concentrator. Take an unused RJ-45 jack and plug the cable at the concentrator into it.

4. Take an ohmmeter and check continuity between the conductors. They should all be the same and not

ANSWER TO #9942 - SEPT. 1994

The circuit you are looking for is commonly known as a sound or voice operated switch. The switch, in this case, would control the "muting" of the AM radio speaker. I don't know about the universality of any particular circuit since you would have to modify the AM radio to gain access to either the speaker terminals or volume control. In any case, one possible solution is as follows:

An electret microphone is placed directly in front of the scanner speaker. When the microphone (x1) picks up sound (usually voice) from the speaker, the sound signal is amplified,

detected, and activates a retriggerable one-shot circuit which controls the relay (K1). The relay controls the AM radio speaker, muting it when sound is detected.

ed from the scanner. See Figure 1 for circuit details.

Kevin Goodwin
Oceanside, CA

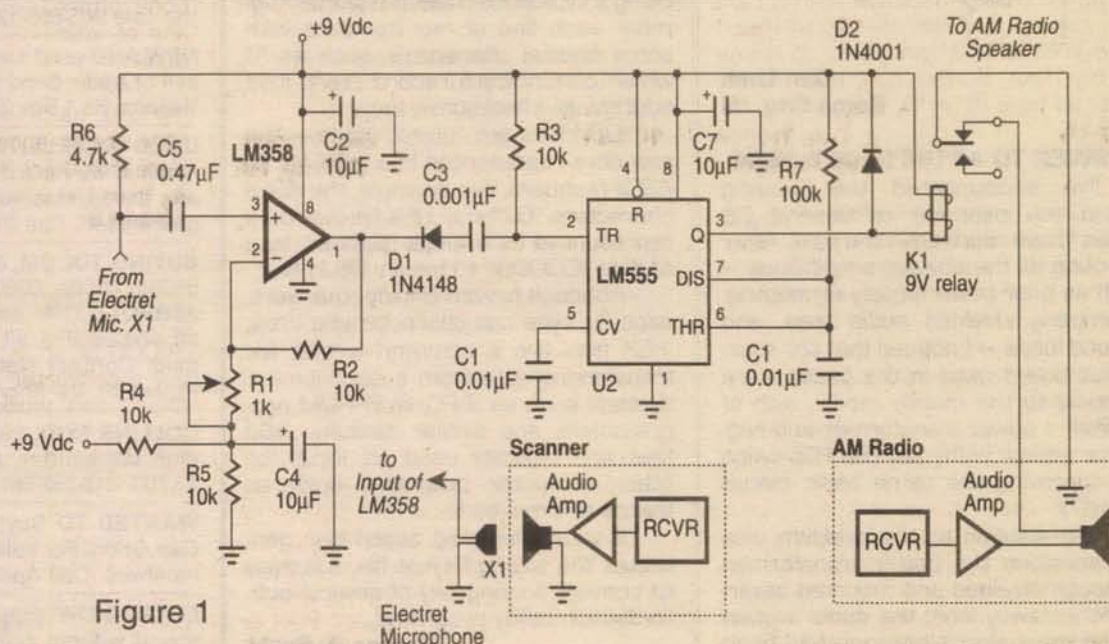


Figure 1

TECH FORUM

vary by more than 1- to 2-tenths of an ohm. Move the cable around to make sure that there are no intermittent conductors.

5. Repeat same procedure with shorted jack at concentrator end and checking continuity from terminal end. A typical cable run should have a resistance from 5 to 10 ohms.

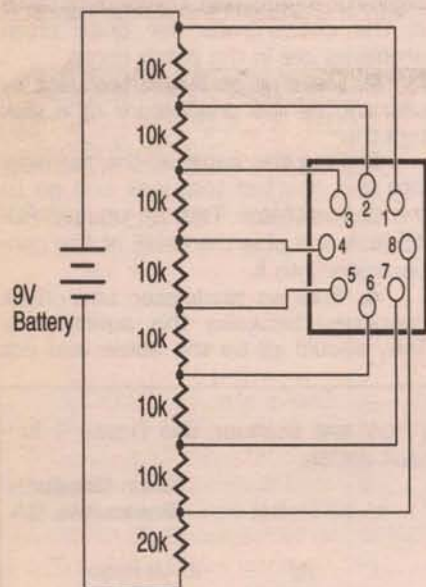
6. Check resistance of cable run to ground to make sure the cable jockey that pulled the wire didn't snag the cable to ground. If you still have the shorting jack on either end, this test could be done by testing continuity between any conductor and ground. Any resistance reading is indicative of a cable shorted to ground.

7. Remove shorting jack and check cable for any short between conductors.

8. Bear in mind that most RJ-45 applications don't use all eight conductors.

9. To check for proper pin-out, you could make up a simple apparatus like the one shown below and then compare it with a known good cable run. On a straight-through cable, pins 1 thru 8 would yield a reading of 0 to 7 volts respectively, using a good 9-volt battery and a digital voltmeter.

The test equipment you are wishing you had injects high frequency signals down the cable and checks for crosstalk, dB losses, etc. Unless you are operating above 10 MHz, you can spot most problems using the methods outlined here.



Dan Lash
Rome City, IN

ANSWER TO #11941 - OCT. 1994

I've encountered the buzzing sound you describe on several CB bases I have repaired in the past. After checking all the obvious possibilities — such as poor power supply decoupling, improperly shielded audio lines, and ground loops — I noticed that the main circuit board used in the bases were identical to the mobile model, with of course, a power transformer and regulator added. (Why pay the FCC twice for approving the same basic circuit board?)

The solution to the problem was to reposition the power transformer. Although shielded and mounted several inches away from the audio section of the main circuit board, it had been responsible for introducing the buzzing

sound.

I soldered extension wires onto the transformer leads and while listening to the buzz, moved the transformer around until a location was found where the buzz disappeared. In one case, the transformer had to be rotated 90 degrees as well.

R.D. Van Dyke
Charlo, MT

ANSWER TO #119412 - OCT. 1994

No, capacitive strips cannot be read through a car by the police. Not even in Georgia. The "strips" in money are aluminum foil, marked with the denomination of the currency and scannable by electronic counters in banks. There is no "long range" scanner for these bills. To see the strip, just look at a new fiver or sawbuck (most of us don't have anything larger) held up to the light. You will see the strip on the east side of the bill running top to bottom. The strip can be pulled out of the bill with care, although it is against the law to deface U.S. currency, so don't do it.

The probable reason your friend was pulled over is: He cannot withdraw more than \$10,000 cash at one time, so the bank reported him to the police as a suspected felon under the RICO laws, where large cash withdrawals usually indicate drug deals or something like that.

Henry M. Hamerman
Lansdale, PA

ANSWER TO #11946 - OCT. 1994

The .HEX and .OBJ extensions indicate two different file formats. They probably contain the same underlying data, although different assemblers may produce slightly different codes depending on how macro procedures and other higher level functions are handled.

.HEX files are printable ASCII hexadecimal format. These files consist of line after line of hex numbers in a fixed format. A typical line might be: 12A574BC81F595217941B746C etc.

Each two ASCII characters in a .HEX file actually represents only one byte of data. Hex files can be formatted according to a given set of rules, with the Motorola "S-record" format being a typical example. S-records augment each line of hex numbers with some special characters, such as ":" which can indicate record start, load addresses, checksums, etc.

.OBJ files are "object" code — the raw data represented in a .HEX file by ASCII numbers. For example, the ASCII characters "07" in a .HEX file would be represented by a single eight-bit byte of data (00000111) in an .OBJ file.

Although fundamentally equivalent, each file type has characteristic uses. .HEX files are a common format for transferring data from a development system, such as a PC, to EPROM programmers and similar devices. .OBJ files are typically used as input for other computer programs such as linkers or emulators.

If your preferred assembler generates the wrong format file, it is easy to convert it using any of several public domain utility programs.

George R. Scott
Alexandria, VA

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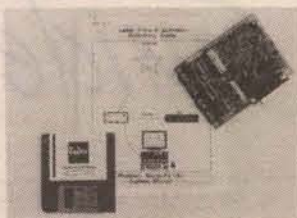
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Nuts & Volts Magazine/November 1994 81

Everyone who already has a microcomputer, or plans to get one, should get a copy of "The Secret Guide to Computers," by guru Russ Walter. Now in its 19th edition, this 639 page book contains tips, techniques, and guidance you might expect from a paid personal computer consultant.

In 53 finely-tuned chapters, Walter's light-hearted approach unveils the mystery of what, why, and how for the average non-technical user — information that has been literally drowned out by the information overload presented in most magazines and books. And Walter offers free 24-hour telephone help. (How can he do that?)

Russ Walter has done it again! His latest 19th edition of *The Secret Guide to Computers* is another treasure-trove of information about microcomputers — old and new alike.

This amazing 8.5- by 11.5-inch 639-page illustrated tome goes back in time to discuss micros like the original Radio Shack TRS-80, the Commodore Pet, and the Apple — yet covers the latest versions of DOS and Macintosh operating systems.

I've been aware of *The Secret Guide* since the early 1980s, but have not seen it since then until recently. Beginning with the free 17-page edition 0 in 1972, *The Secret Guide's* 12th edition in 1986 blossomed into a three-volume set. The new 19th edition is a single 2.5-pound volume with economies of production that result in a single-copy price of only \$15.00 — with generous discounts down to \$4.95 per copy — and that's postage paid to all countries! (How can he do that?)

Walter's guides and services have been praised on the front page of *The Wall Street Journal*. They've also been praised and used by CBS News, *USA Today*, *The New York Times*, *PC Magazine*, *PC World*, *Infoworld*, *Byte*, *Mac User*, *The Australian*, and dozens of other publications around the world.

The 19th edition is a MAJOR upgrade. It contains more than 10,000 improvements over the 18th edition. It is up-to-date, detailed, comprehensive, frank, and easy to read. Kids love its easy English; adults love its ruthless truths.

Even more incredible is that Russ Walter personally offers FREE computer help on his Computer Samaritan 24-hour hotline, stating that he only sleeps lightly. He even invites "drop-ins" at his home, with instructions by car or subway. (How can he do that?)

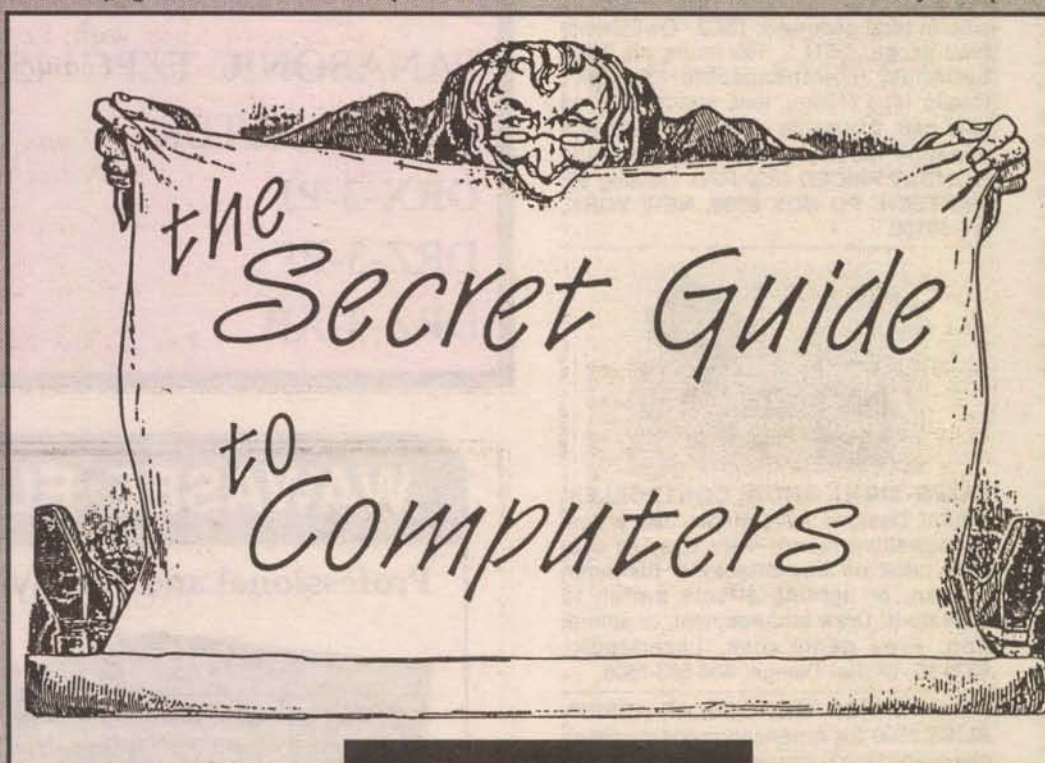
To make the 19th edition better than ever, Russ totally reorganized the guide's contents so you can find any computer topic pronto using a front cover topic guide, a detailed Table of Contents, and a six-page small-print Master Index. The guide is divided into eight sections, 53 chapters in total, as shown in Table I.

The guide analyzes the newest bargain computers and peripherals, and discloses a Secret Formula that determines the value of any modern IBM PC clone. The "Repairs" chapter includes about twice as many tricks for fixing computer problems yourself. A nasty glossary reveals the real meaning of the fine print and disclaimers at the bottom of computer ads.

Early editions of the guide covered MS-DOS up

through Version 5. In the 19th edition, advanced commands are included from DOS 6, 6.2, and 6.22. The 19th edition also contains new tricks for editing your CONFIG.SYS and AUTOEXEC.BAT files. These tricks are claimed to give you about 620K of conventional RAM free (plus many megabytes of upper and extended RAM) without buying a memory manager and without the hassles suffered by hoards of frustrated computer users! Your Windows, business software, games, and CD-ROM software will run smooth as silk. (How can he do that?)

Other topics include: how to use the Mac's



by Fred Blechman

System 7 and System 7P; tricks of big word processors such as Word Perfect, Ami Pro, MS Word; tricks for using the newest DOS versions of 1-2-3 and Quattro Pro; clever techniques used by modern Excel (for Windows & Mac); how to get in business as a computer consultant; and how to fix computer problems by chatting on the phone.

Here are some reasons to buy the 19th edition: it's funny; it's easy to read; it contains tricks you can't find anywhere else; it saves you money when you buy hardware and software; it brings you up-to-date and fills in the holes in your background; it saves you the time, expense, and frustration of calling tech-support staffs.

Though the 19th edition is gigantic, a single copy sells for just \$15.00. To pay even less, join your friends and place a group order: for 2 copies, you pay \$12.00 per copy; for 4 copies, you pay \$9.00 per copy; for 60 copies, you pay \$6.00 per copy; for 666 copies, you pay \$4.95 per copy — shipping included! (How can he do that?)

Here's more incredible news. You may reprint all or part of this book free, without paying royal-

ties! Just phone Russ Walter first, send him one copy of your reprint, and begin your reprint with an acknowledgment paragraph copied from page 9 of the guide. To assist you in doing this, you can request the entire guide on disks (same price as a book), so long as you specify disk capacity (360K, 1.2M, 720K, or 1.44M) and which format (Word Perfect 5.1 or ASCII). The disks include 62 files totaling over three megabytes. If you get the book on disks, get at least one book on paper since the disks do not contain headlines, graphics, special symbols, and printer drivers.

Who is this guy Russ Walter, anyhow? In this self-question "interview," condensed from pages 8 and 9 of the guide, and reprinted here with permission, you'll get some insight . . .

* *Why did you write the Secret Guide?* I saw my students spending too much effort taking notes, so I made up my own notes to hand them. Over the years, my notes got longer, so that the 19th edition totals 639 pages. Each time I develop a new edition, I try to make it the kind of book I wish I had when I was a student.

* *What does the guide cover?* Everything. Every computer topic is touched on, and the most important topics are covered in depth.

* *Who reads the guide?* All sorts. Kids read it because it's easy; computer professionals read it because it contains lots of secret tidbits you can't find anywhere else.

* *Why do you charge so little?* I'm not trying to make a profit. I'm just trying to make people happy — by charging as little as possible, while still covering my expenses. Instead of "charging as much as the market will bear," I try to "charge so little that the public will cheer."

* *Do you really answer the phone 24 hours a day? When do you sleep?* When folks call in the middle of the night, I wake up, answer their questions, then go back to bed. I'm near the phone 85% of the time. If you get no answer, I'm out on a brief

errand, so please call again. If you get an answering machine, I'm out on a longer project: just leave your number and I'll call you back at my expense, even if it's long distance.

* *Why do you give phone help free? Are you a masochist, a saint, or a nut?* I give the free help for three reasons: I like to be a nice guy; it keeps me in touch with my readers, who suggest how to improve the guide further; and the happy callers tell their friends about me, so I don't have to spend money on advertising.

* *At computer shows, do you really appear as a witch?* I wear a witch's black hat and red kimono over a monk's habit and roller skates, while my white gloves caress an African spear. Why? Because it's fun!

* *Did you write the whole guide yourself?* Yes, but I received many suggestions from my readers, friends, and staff, who also contributed some examples and phrases.

* *What's your background?* I got degrees in math and education from Dartmouth and Harvard, taught at several colleges (Wellesley, Wesleyan, and Northeastern), and was a founding editor of *Personal Computing* magazine. But most of my expertise comes from spending long

hours every day reading computer books and magazines, discussing computer questions on the phone, and analyzing the philosophy underlying the computer industry.

And here are excerpts of Russ Walter's "bio," in his own inimitable words:

"The author, Russypoo, was conceived in 1946. So was the modern ("stored-program") computer. Nine months later, Russypoo was hatched. The modern computer took a few years longer, so Russ got a head start. But the computer quickly caught up. Ever since, they've been racing against each other, to see who's smartest. The race is close, because Russ and the computer have so much in common. Folks say the computer "acts human" and say Russ's personality is "as dead as a computer."

"To try beating the computer, Russ got his bachelor's degree in math from Dartmouth in 1969 and sadly remained a bachelor ever since (unless you count the computer he got married to). After Dartmouth, he got an M.A.T. in math education from Harvard. Since he went to Harvard, you know he's a genius. Like most geni, he achieved the high honor of being a junior-high teacher. After his classes showered him with the Paper Airplane Award, he moved on to teach at an exclusive private school for girls who were very exclusive. ("Exclusive" means everyone can come except you.)

"After teaching every grade from 2 through 12 (he taught the 2nd-grade girls how to run the computer, and the 12th graders less intellectual things), he fled reality by joining Wesleyan University's math Ph.D. program in Connecticut's Middletown (the middle of Nowhere), where after 18 months of highbrow hoopla he was seduced by a computer to whom he's now happily married.

"Russ moved with his electrifying wife to Northeastern University in Boston (home of the bean and the cod), where he did a hilarious job of teaching in the naughty Department of "Graphic Science." After quitting Northeastern and also editorship of Personal Computing, he spends his time now happily losing money by publishing this book.

"Since his wife was lonely, he bought her 40 computers to keep her company, with names such as "Anita Atari," "Aphrodite the

Apple," "Baby Blue Burping Bonnie," "Coco the Incredible Clown," "Jack the Shack," "Kooky Casio," "Slick Vic," and "Terrible Tina with her Texas Instruments." He hid them in a van and drove them around the country, where they performed orgies and did a strip tease, to show students a thing or two about computer anatomy."

To order books, disks, or to request more information, call Russ Walter at (616) 666-2666. For a single copy, send \$15.00 check, money order, or cash (US dollars) to: The Secret Guide to Computers, 22 Ashland St., Floor 2, Somerville, MA 02144-3202. **NV**

Fred Blechman has written over 650 magazine articles and five books about microcomputers and electronics since 1961.

TABLE I The Secret Guide to Computers Sections and Chapters

Welcome

Buyer's Guide

Chips
Disks
Screens
Printers
Other Hardware
Software
IBM Compatibles
Apple
Alternative Computers

Operating Systems

MS-DOS
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DBASE
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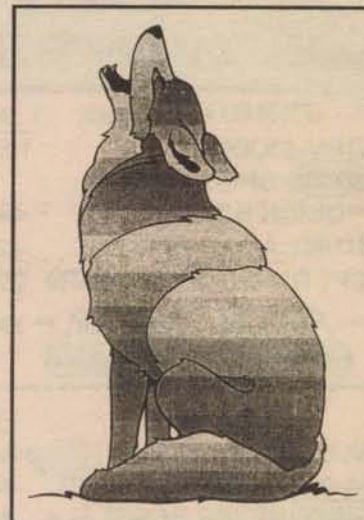
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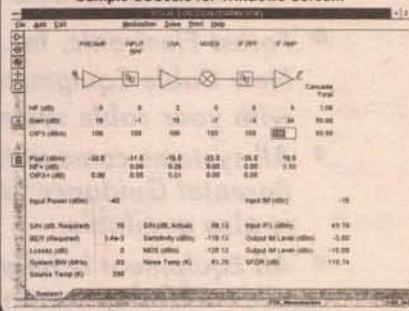
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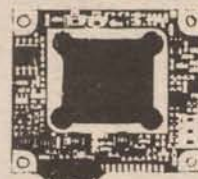
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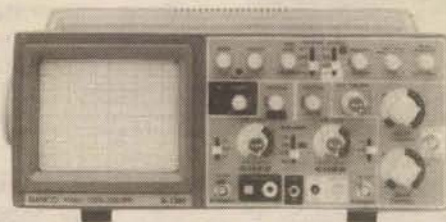


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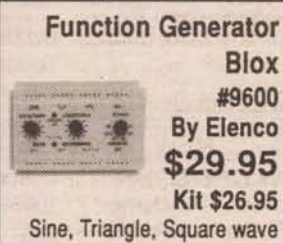


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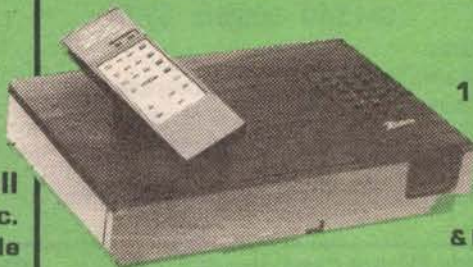
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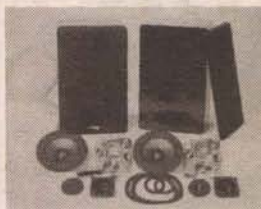
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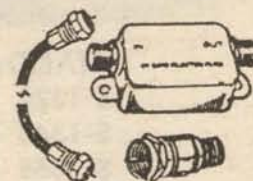
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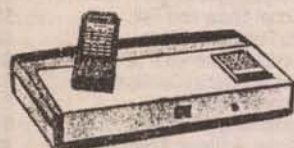
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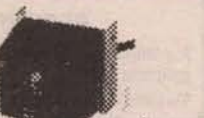
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RESOURCE BIN

number thirty-four

New developments in remote controls.

Our usual reminder here that the *Resource Bin* is now a two-way column. You can get tech help, consultant referrals, and off-the-wall networking on nearly any electronic, *tinaja* questing, personal publishing, money machine, or computer topic by calling me at (602) 428-4073 weekdays 8-5 Mountain Standard Time.

A portion of my PSRT RoundTable on *GENIE* has also been set aside for you *Nuts & Volts* readers. This is the place you go for instant tech answers. Among the many files in our library, you will find complete reprints for all the *Resource Bin* columns.

I did manage to wrangle a super special sign-up deal for you *Resource Bin* readers. Ten free hours and zero first month minimums. See the trailer blurb for details.

Remote Controls

There sure has been a lot of helpline interest lately in remote controls. So, this month I thought I'd try a remote roundup. Especially since there's two brand new players here having lots of hacker possibilities — modifying heart rate monitors and the superb *E-series* by *DesignTech International*.

The object of any remote control, of course, is to send commands or ID signals over a distance. There is no "best" way for all possible uses.

Important considerations are the range, the reliability, your cost, the media, the power, the transmitter or receiver size, licensing and legality restrictions, the ruggedness, ease of use, the data rate, duplex potential, compliance to any standards, packet collisions, and potential interference both between units and any outside conflicting sources.

There's lots to select from.

Let's look at some of our options here. To sort this all out, we'll work our way up more or less in order of increasing frequency...

Heart Rate Monitors

Let's start off with a real sleeper

of a hacker opportunity. One that is still going begging.

I like to define *short haul telemetry* as any scheme which is usable to send information over a very limited range. Say five feet or so. The obvious uses include exercise gear, *isopods* for safe monitoring of power line currents, and home energy consumption, counting cows, for robotics, providing security ID, or getting info on or off a rotating shaft. Or other moving object.

There's an aerobic exercise beastie called a *chest style heart monitor*. You wear a strap on your chest. The strap uses body contacts to sense the EKG electrical heart signals. It transmits to a nearby display, usually worn on your wrist or mounted on a bicycle. For its intended purpose, this system is vastly more convenient and more reliable than those nearly useless IR *plethysmograph* devices.

Mostly because there's no *motion artifacts* and because you can see your results at a single glance.

But what you really have here is a low-cost and easily-hacked universal short haul telemetry system. It works by inductive coupling, as an air core transformer between transmitter and nearby receiver.

NEXT MONTH: Don looks at the most popular hardware hacking parts of all time.

Each heartbeat gets sensed as a microvolt signal and converted into a 36-cycle burst of 5 KHz energy. These bursts are easily received with any old multi-turn iron core coil. Except for a deep axis null, the response is largely omni-directional.

Total manufacturing parts cost in quantity is \$5.00 or so. For a micropower, sealed, and reasonably waterproof system. The internal lithium coin cell usually lasts a year or more.

For hacker use, you would convert whatever it is you want to sense into a low frequency series of pulses. Max rate is in the 50 to 100 PPS

range. The bursts themselves could get used for simpler remote controls, while their repetition rate could be used to send out analog data.

WARNING: Do not open, disassemble, or modify a heart monitor in any manner if it's ever again to be used for any human or animal purpose!

One popular heart monitor brand is *Polar*. Many variants are stocked by *Creative Health Products*. Replacement chest units list for \$24.00 or so.

There's several other resources for short haul telemetry in general. *Dallas Semiconductor* has lots of fine stuff in this area. The topic is also covered in such obscure trade journals as *Access Control*, the *Identification Journal*, in *ID Systems*, or *Automatic ID News*.

More info on pulse monitors in HACK68.PS. And more on *isopod* short haul telemetry in HACK47.PS.

Audio Tones

Plain old audio tones can get used for remote control. The usual ploy is to generate a tone either electronically or with a whistle. Detection is often by a bandpass filter followed by a 567 phase lock loop tone decoder.

You'll find whistle-type remotes in those *DYS (distressed yuppie surplus)* catalogs. The wholesale sources can be found in *ASD/AMD Trade News* and in the really great, but pricey offshore publications from *Asian Sources*.

Besides sounding obnoxious, most whistle systems are unreliable.

So, instead of designing your own audio remotes from scratch, it makes far more sense to use existing systems and standards. Touch tone is a good route. Major sources of phone chips include *Teltone*, *Silicon Systems*, and *Sierra Semiconductor*.

Pager tones could also be a useful choice. One popular system is called *HSC*, short for *hexadecimal sequential code*. Those *MX503* transmitter and *MX013* receiver chips from *MX-COM* are typical examples.

Even cuter than pager tones is the *CTCSS*. Short for *continuous tone, sub-audio squelch*. These form a group of standard *sub-audio* frequencies from 67 to 250 Hertz. These are usually *below* normal voice comm frequencies and thus (with care) cannot be heard. The *MX265A* is a typical encoder/decoder chip, again from *MX-COM*.

A special low-pass filtering gets included to prevent speech or other audio interference.

The intended use for *CTCSS* is to send private messages over a

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common radio channel. Presumably, only the intended receiver gets activated when the tone is present. All of the other receivers remain mute.

But the extension to slide show or multimedia controllers is obvious. So is any other use where you want to send "silent" control signals over any live audio channel.

Because of those very low carrier frequencies, the acceptable signalling rate is very low. Ten commands per second or less. The channel usually has to be voice grade only, since bass music tones would interfere with the remote control signals. But you could compromise and use only the lowest tones and a lower audio cutoff.

Much more on using CTCSS in HACK71.PS on GENIE PSRT.

Carrier Comm and BSR

The power lines run all over your house. Why not try to use them for signalling and intercoms and remote control? This scheme is called *carrier communications*. One of the first real jobs I ever held was designing carrier comm for mine safety.

Traditionally, a frequency in the 50-200 KHz range got itself FM modulated with the voice or control signals, coupled to the power lines or train tracks or trolley overhead, and then received and decoded where it's needed. But these days, you may find severe problems in trying to use the power lines for carrier comm.

First, because many light dimmers can generate an incredible

amount of power line interference. Second, most computers and their peripherals have powerful line noise filters that can literally short out the carrier comm frequencies. And third because there are new and severe restrictions (both FCC and European) on the allowable power levels.

Your most popular carrier current scheme is the BSR system. A series of transmitter and receiver modules that are intended for home automation uses. The classic insider secrets story on these appeared in the September 1980 *Radio Electronics*. Besides BSR themselves, *Heath*, and *Radio Shack*, *Circuit Cellar* sells lots of construction projects and computer interfaces.

The main negatives about the BSR system? It is one way only, leaving you with no verification over whether the action actually took place. Which can cause major safety problems in industrial controls. Most houses split up their 220 volts incoming into two separate 110 volt distribution phases. Any BSR coupling between phases is usually poor to totally lacking.

The max data rate is extremely slow. There is zero collision avoidance for multiple senders. System noise immunity is poor. As we've already seen, any single frequency power line carrier current comm is easily trashed by dimmers and noise filters. And neighboring houses can interfere.

Nonetheless, the BSR system is a cheap and computer-friendly route

to home automation.

An obvious carrier comm solution is waiting in the wings. And this is to go to *spread spectrum* systems where the *entire* frequency range from mid audio up to the AM broadcast band is used. Thus, dramatically improving the noise immunity and ability to deal with line filters.

By using different spreading codes, multiple transmitters can work with their intended receivers. And do so totally interference free. Full duplex two-way comm is also a snap.

One very high profile approach to spread spectrum remote control is the *LonWorks* from *Motorola*. But after I had read all of their expensive promo materials, I am left with a feeling of "Did they do this on purpose?" To me, their grossly overblown *LonWorks* fiasco appears to be a textbook perfect example of a megacorporation run amuck. And an outright con. Any kid in a garage could easily come up with a cheaper and simpler system.

Sorry, but there is way too much baggage here. Whatever happened to elegant simplicity? Any \$2.00 PIC chip makes a lot more sense to me.

Both *SGS* and *Signetics-Philips* now offer new spread spectrum power line control chips. More on these after I check them out.

Ultrasonics

Once long ago, ultrasonic remote controls in the 40 KHz range were quite common. But their popularity clearly has peaked. In general,

nearly anything you can do with ultrasonics can get done simpler, cheaper, and more reliably with infrared.

But you can find these at zero cost on junker TV sets, and they are still used as a BSR option. They also see use as "tapeless" tape measures.

The ultrasonic transducers remain available surplus, often priced from \$2.00 to \$5.00. Do note that *higher voltages, custom step-up transformers, plus very careful matching are needed.*

Note also that ultrasonic signals literally blow away outdoors in the wind. And that vehicle engine fans can generate an incredible amount of interfering ultrasonic energy.

Most of the infrared receiver and controller chips can also be used for ultrasonics; more on this shortly.

Ham Radio

Many radio amateurs have a lot of interest in remote controls. Especially for the *autopatch* routines needed by repeaters. Much of this has now been published in the ham magazines and in tightly targeted newsletters such as *Repeater Journal*. Lots of kits and low-cost systems are available.

See my *Resource Bin* reprints or else NUTS17.PS for more info.

Citizens Band

Most of those radio-controlled toys and models use license free Citizen's Band radio frequencies in the 27 MHz range. Often with a power limit of 100 milliwatts or less. *Radio Shack* has a low-cost remote control kit. And mags such as *R-C Modeler* are crammed full of ads for ready-to-go units.

Citizen's Band remotes have major interference problems. But they can do a lot of tasks cheaply and simply over useful ranges. Pulse modulation servo techniques can be used to send analog control signals.

A good source for remote control chips is *Samsung*. Especially in their *Linear Data Book*. Full transmitter and receiver schematics are included. The KA2303 (three-channel decoder), KA2309 (seven-channel decoder), and KA2310 (seven-channel encoder) devices are typical modern examples.

These circuits are often combined with super-regenerative receivers. But do note that any homebrew super-reg must provide a preceding RF amplifier stage. Otherwise, it might generate severe interference and trash out the intended band of operation.

FM Broadcast Band

There's a lot of misinformation

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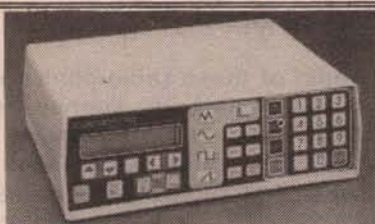
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out there over FM broadcaster systems for voice and remote control uses. Most of those widely advertised low-cost devices are (A) highly illegal; (B) have nowhere near their claimed distance; and (C) most will not work at all with synthesized FM receivers!

The problem is that a properly done FM transmitter *must* be very stable and be frequency pullable with the audio or control information. Units that drift around can *not* be properly received on a digitally synthesized radio. Even a rock stable unit often will *not* get received if it is not closely locked to a standard FM channel.

Let's start with professional gear. Commercial FM *wireless* microphones are readily available, both in and out of the FM band. You'll find lots of ads for these in *TV Technology*, in *Radio World*, and similar trade journals. The units can also be rented.

The standard hacker chip here is the really great *Rohm* BA-1404, which combines its FM stereo multiplexer with an RF transmitter. The bottom line is that their stereo part works like a champ if a 38 KHz crystal is used for the stereo pilot. But their transmitter portion is *totally useless*.

A good compromise solution is to modify any CD to car radio adaptor. These combine a BA1404 with an ultra stable crystal controlled RF oscillator. Through very careful circuit design, their oscillator is both rock solid and can get linearly modulated over the full stereo spectrum.

Typical units here are the *Pioneer* CD-FM-1 or the *Sony* XA-7A. Costs are in the \$30.00 range. The Pioneer unit is larger and more easily hacked. The Sony model offers two channels. For increased range, a small booster stage could be added, possibly using one of the many wideband amp chips from *Mini-Circuit Labs*.

More on these topics in HACK24.PS and HACK52.PS on *GENIE* PSRT.

The Best Remote of All . . .

Very few people realize there's an obscure paragraph or two buried in part 15 of the FCC regs that allows licence free remote controls with *ten times* the usual power. Mark Gottlieb of *DesignTech International* has come up with several superb new hacker remote controls operating in the UHF range at 330 MHz. They are intended mainly for on-off control commands and similar low data rate uses.

The transmitters are the size of a keychain tag. In fact, that's what they are. They have got one, two, or three buttons on them, sending a selected code from the 16,777,216 possible. A monitor LED lights red,

yellow, or green for the chosen channel.

#20051-E is a one-code transmitter at \$44.95. The #20061-E is a three-code transmitter at \$49.95. These differ only in the number of buttons.

#30021-E is a compact four code, single channel receiver. Any of four transmitter codes causes an output relay to close for half a second.

Power can be done "hacker mode" from an external 12-volt wall adaptor. Or the "garage mode" power can be robbed from a conventional garage door control loop. Multiple channel receivers are also available.

A five inch antenna is needed. If possible, your receiver should get placed high and line of sight. Hold the transmitter horizontally.

The effective range easily exceeds 300 feet line of sight. The signals also can pass through car windshields or walls of ordinary construction.

Which makes this great new system ideal for many "long driveway" apps. Or for remote gates. Or countless farm or industry applications. I've now got these in use here at my *Synergetics* as a remote "get-the-phone" signal.

A #30020-E transmitter receiver pair is also offered at \$79.95. Contact them directly for info on their other unique remote control products.

More circuit details and plenty of application info on these appears in HACK82.PS on *GENIE* PSRT.

Wireless Solutions

There's now a brand new 900 MHz *wireless* band. Nearly everybody is scrambling all over each other to offer powerful new spread spectrum mice, modems, and similar two-way remote controls. License free.

So 900 MHz is definitely where the future action will come down. Today, though, the products are still klutzy and expensive. Many still share their gold-plated military background. This near-microwave frequency range is hard to hack because of the exotic test gear and specialized knowledge.

Not to mention the black magic. But it is getting ridiculously easier than it once was. Is it ever.

If you do not know what a Smith Chart is, you can forget about most wireless work. If you do know what one is, you'll find lots of them in SMITHCHT.PS on *GENIE* PSRT.

The best new trade journal here is *Wireless Design & Development*. Such older mags as *Microwave Journal*, *RF Design*, and *Microwaves & RF* have lots to offer as well.

One source for surplus transmit-

ters and receivers is *Fair Radio Sales*. But watch the legality here.

Infrared and Optics

Most television and VCR remotes now send IR light. By pulse width modulating a low-cost light emitting diode. These work fairly well, and have pretty much replaced the older ultrasonic remotes. So long as only one IR unit is active at once.

The IR light is fairly good at bumper shot bouncing off walls, but it cannot get through a closed door. Longer range repeater units are available that can relay the commands down halls. As are intelligent remotes that can be "taught" the codes for any number of VCRs, TVs, or CDs.

One leading chip source here is *Plessey*. Who has encoders, decoders, and receivers. Start with their *Cable, TV, and Audio Databook*. Older parts here include the SL486 receiver and the SL490 transmitter.

An *Infrared Remote Control ICs* data pack from *NEC* is also very useful. It has good info on their programmable uPD6125 device.

By the way, replacement remote controls and control chips are stocked by *ECG*, by *NTE*, and by various other advertisers in *Electronic Servicing*.

This Month's Contest

For our contest this month, just tell me about any unusual remote control problem or solution you might have. There will be a largish pile of my new *Incredible Secret Money Machine II* books going to the dozen or so better entries, plus an all-expense-paid (FOB Thatcher, AZ) *tinaja quest* for two that will go to the very best of all.

Let's hear from you. **NV**

Microcomputer pioneer and guru Don Lancaster is the author of 32 books and countless tech articles. Don maintains his no-charge tech helpline found at (602) 428-4073, besides offering all of his own books, reprints, and all of his consulting services. He also has a free catalog full of his resource secrets waiting for you. Your best calling times are 8-5 on weekdays, Mountain Standard Time.

Don is now the sysop of GENIE PSRT, where a special Resource Bin topic has been reserved for Nuts & Volts readers. For fast modem access, use (800) 638-8369 and enter HHH. When prompted, enter JOINGENIE. When asked for a keyword, enter DMD524.

You can also reach Don at Synergetics, Box 809, Thatcher, AZ 85552. Or send any messages to his Internet address of SYNERGETICS@GENIE.GEIS.COM.

AMATEUR ROBOTICS

Okay," I said, "let's hit it." Marvin Green and I trooped upstairs to my workroom — two men on a mission. We intended to do some serious robot hacking that night, and it was time to get started.

We had selected a non-trivial project. Months ago, I had bought several TV IR remote controls for 99 cents each at a local surplus shop. Tonight, Marvin and I were determined to deduce the coding scheme used by the controls, then use the handhelds to control Max, my newest robot.

Marvin sat down at my electronics workbench, grabbed a small screwdriver, and started opening the control. He said, "First, I want to use your 'scope to look at the pulses you get when you press a button on this thing."

"No problem," I responded, and gave him a quick rundown on my old Tektronix 454 oscilloscope.

I watched Marvin clip the 'scope's input lead to the control's IR LED at the junction between the LED and its current limiting resistor. When he pressed a button on the remote, a pattern blinked briefly on the 'scope's screen. Some buttons gave a repetitive pattern, making them easier to examine.

"I set the horizontal timing way down, and you can clearly see this remote is sending 40 KHz bursts for each pulse," he noted. "This thing should directly drive one of those Sharp IR detector modules that Electronic Goldmine sells."

"Great!" I had hoped this was the case. "Some of the older controls used other frequencies; I'll take this as a good omen."

I left him with my engineering notebook and pencil, staring at the oscilloscope and making notes. I wheeled my chair up to the computer desk and hit the power switch on my 386.

Our plan of attack was simple. Marvin would glean what he could about the pulse stream by observing traces on the 'scope. I would use that information to write a simple program to monitor the output of an IR detector module.

Then, we would aim the remote at the detector module, press some buttons, and the program would report the incoming pulse stream. Based on this new information, I would then write a second program that (hopefully) would let us run Max using the remote control.

The SRS meeting

Marvin had driven up from Portland the day before to attend that month's meeting of the Seattle Robotics Society. As we worked, we discussed the meeting.

"The guys really liked your little robot frame kit, Marvin," I said, referring to his latest creation — the B-BOT frame. "You did a beautiful job on the design and the workmanship."

"Yeah," he replied, "I found a plastics shop that would make them for me just like I want them. You think \$29.95 is a reasonable price for a two-level robot frame kit?"

"Of course!" I was kind of surprised at the question. "That black plastic frame, clear dome, and plastic skirt look first-rate. How many did you sell at today's meeting?"

"Oh, I sold 10 or so. They went fast; I just wish I had had a few more ready for today."

"Well, think about what you are offering for \$30.00. Someone can take your frame kit, add a couple of servo motors, a BOTBoard, and some batteries, and create a working robot in just an

evening or two." I glared for a moment at my code that was not working out, then went back to the conversation.

"Your bumper skirt is ingenious, so simple and easy to build. Plus, you get 100% coverage on the robot's perimeter. Guys in the club have spent years trying to come up with something even half as good, and failed."

"Well, I just modified some other designs I saw, eliminated things that looked too difficult to make or buy, and replaced them with rubber bands and common hardware," he said. "No big deal."

I had noticed this before about Marvin's designs. They were always the simplest, most effective solutions to some nagging problem. He never added anything that wasn't necessary, and he always used pieces that you could easily buy or make.

"Well, as soon as word gets out about your frame kit," I said, "you're going to get a flood of orders. Someone could use it for a science fair, a class project, or almost any kind of robot experiment. Heck, the frames are so cheap, you could even build a herd of robots and play with interaction between robots."

Marvin changed the subject. "Well, I saw a lot of other really neat robots today. The guy with the two robots using tank treads did a great job building his machines."

"That was Bob Dain," I replied. "Yeah, those were nice 'bots. He said he got the tank tread at a hobby store, then just strung it around the wheels he had built onto his frames. And boy, that one machine was fast!"

"And Tom Dickens had a couple of nice little servo-driven robots," said Marvin. "I thought his front bumper switch was pretty clever."

"Yeah," I agreed, "I'm glad Tom is working with BOTBoards now. He is really sharp, and I can't wait to see what other kinds of robots he comes up with."

"Tom is using your BOTBoards as the core of the microcontroller classes he teaches at Cogswell College in Bellevue. I always thought that would be a great use for BOTBoards."

"Do your meetings usually include a tech session like that talk you gave on Forth?" Marvin asked. "I thought you did a good job on that."

"Well, we always try to have something technical after the general meeting," I answered. "That way, people have a chance to learn from a club expert in some matter. Everyone in the club is experienced in some aspect of robotics, everyone has something to contribute. The technical sessions are where that happens."

Back to the hack

We had been working while all this talking was going on, but Marvin was making better progress than I was. "Okay, I've got a handle on the pulse stream. Here, look at my diagram on the timing of the IR signal..."

He had wired an IR detector up to my oscilloscope input, connected a set of four AA-cell alkalines, and examined the waveforms he got from some button presses.

"You can see here that each burst of 40 KHz IR gives a low-going output pulse about 400 usecs long," said Marvin, pointing to one of the narrow pulses on his diagram.

"The time between each pulse is always either 1 msec or 2 msecs, which I assume indicates a 0 or a 1," he continued. "And each key generates 13 IR pulses, which means you get 12 bits of information."

I picked up the thread. "That means we just need to wire an IR detector to an input on the BOTBoard, then have code time the duration between each two pulses. Anything less than 1.5 msecs is a 0, anything greater is a 1."

"Then the code mashes all the 1s and 0s together to make a character. Since it is easier to work in 8 bits instead of 12, and since the remote only has 18 keys on it, I'll make a look-up table that translates each 12-bit pattern into some ASCII character."

Marvin then asked, "But how are you going to know when a character starts?"

"Simple," I replied. "We'll connect the IR detector's output line to PA7 on the BOTBoard's 68hc11, then configure that pin to generate a PAI interrupt when it sees a low-going edge."

"Pressing a key on the remote generates the first burst of IR to mark the start of the character. That first burst will make the IR detector's output go low, causing a PAI interrupt."

"Once control reaches the PAI interrupt service routine, or ISR, software can start timing the pulses using a simple counting loop. When all the pulses have been tallied, code rearms the PAI interrupt and leaves the ISR. Then the 68hc11 will be ready for the next keypress."

"Okay," said Marvin, "I'll wire an IR detector to Max's computer board. How do you want the connector hooked up?"

"Just use this drawing as a guide," I replied, handing him a diagram I had scribbled out. "Remember to connect the IR module's ground lead to its metal case."

"Yeah, I know all about that," he said. "If you don't make that connection, all you get is noise on the output. Then nothing seems to work."

Software, round 1

I started off by writing a small tiny4th program that did some initialization, then sat in a loop waiting for a variable's value to change.

The real work in this program was done inside the ISR, written in 68hc11 assembly language. The ISR's code timed the incoming pulses, marking them as 1s or 0s based on the timing Marvin had determined.

Next, the code stashed the values in an array, previously declared in the tiny4th portion of the program. The ISR code then wrote a special value into a global variable, as a signal that a keypress had been detected.

Finally, the ISR code re-armed the interrupt and returned, leaving everything ready for the next incoming character.

The tiny4th program, upon seeing that the flag variable had changed, displayed a stream of 1s

and 0s on the terminal to show the incoming data. It then cleared the flag variable and went back into the waiting loop.

Simple stuff, but it wasn't working. I double-checked the ISR code, re-thought the tiny4th code, but no luck. I even hooked an IR detector up to a spare BOTBoard (I've always got a few of those laying around) and hit it with a few blasts from the IR controller. No dice.

"That's it, Marvin," I said in disgust. "I don't know what this stuff is, but it isn't code. Let's take a break."

"Suits me," he responded. "Let's go have some brain food."

This referred to the giant chocolate eclairs we had picked up earlier, while we were getting the pizza and beer for dinner. These were the second-largest eclairs I had ever seen, and each had about a month's worth of sugar and fat in them. Programmer food!

After polishing off an éclair and a glass of milk each (we know the importance of a balanced meal), it was time to tackle the remote control again. By now, it was after 8:00 PM, and we wanted to wrap this thing up tonight.

Marvin went back to the electronics bench to tinker with the 'scope some more, while I headed for the PC. During the break, I had figured out that the problem lay in the initialization of the PAI interrupt. Somehow, I wasn't doing something exactly right.

I had already gone through the Motorola 68hc11 Reference Manual several times, re-reading the section on the Pulse Accumulator Input pin. One more scan wouldn't hurt.

The PAI (pin PA7) is normally used in one of two modes. The gated-time mode accumulates counts ticks derived from the MCU's internal clock for so long as the PA7 input remains at a selected state. This lets your software tell how long the PAI input stays at a specific level.

The event-counting mode increments a register, called the accumulator, each time the PA7

going edge. Therefore, I wrote my initialization code to disable the PAI subsystem, though I did enable the edge-detect interrupt.

After careful reading, I decided instead that I needed to enable the PAI system and disable all unnecessary PAI interrupts. The initialization code then looked like this:

```
: init-pai
  pactl c@
  40 or
  pactl c!
  tmsk2 c@
  10 or
  tmsk2 c!
  10 tflg2 c!
;
```

The first three lines of INIT-PAI fetch the current value for PACTL, set the PAEN bit to enable the PAI subsystem, then write the new value back to PACTL.

The next three lines perform a similar function for the TMSK2 register, setting the PAII bit to allow interrupts on the selected input edge at PA7. By default, this interrupt responds to falling edges on PA7.

Finally, the code writes a 1 to the PAIF bit in the TFLG2 register, resetting the PAI interrupt flag so the next edge will generate an interrupt.

I had already written the PAI ISR code, so I compiled the program, used PCBUG11 to download the object code into my test BOTBoard, reset it, and pressed a key on my remote. The program dutifully displayed a stream of 1s and 0s across the screen!

Marvin heard my excited "Yes!" and came over to look, notebook in hand. "Watch this, Marvin," I said, as I played with some of the buttons. "Now we can see what the codes really look like."

"Great! See how they compare with my notes here." He had carefully written out the pulse pattern for each of the 18 keys, using Ss for short

"Well, I need to write the next version of this software, so it translates keypresses into specific ASCII characters and puts the characters into a queue for later use."

"How about if you build a foot-long, three-wire cable so we can stick an IR detector on a piece of brass rod, fix the rod so the detector is pointing straight up, then attach the rod to Max's top platform?"

Marvin started rooting around in my wire bin for the appropriate connectors and cable, leaving me to tackle the software. But this program would prove easier than the first, since the hardest part was already working.

I started with the prototype software we had just tested. The bit patterns we had logged actually consisted of a three-bit prefix, a five-bit data section, and a four-bit suffix. The prefix and suffix portions were identical for all 18 keys, so I decided to use this fact to help weed out noise and bogus signals.

I added code to the existing ISR module that tested for the proper prefix and suffix patterns. Other code verified that each pulse was no more than the prescribed length, and that no gap between pulses exceeded arbitrarily defined minima or maxima.

This added lots of code to the ISR, but I felt sure the extra security was worthwhile. After all, Max weighs quite a bit, and I wanted to avoid having it start up at full speed because of a false signal.

I built in a conversion table, so each button on the remote control was translated into a specific uppercase ASCII letter.

I also added a queue mechanism, so incoming characters would be saved by the ISR into a small buffer. They would sit there until the main program fetched them from the queue, or until the queue wrapped around and clobbered them.

I felt the queue was necessary since some of the remote's keys send a stream of characters for so long as the key is held down, rather than only as you press it. The queue would help make sure the program saw all the incoming characters.

Finally, I wrote code to connect the character queue to tiny4th's KEY and ?TERMINAL words, normally used to handle characters input via the serial port. With this mechanism in place, my tiny4th code only needed to invoke ?TERMINAL to check the incoming queue, or invoke KEY to fetch the next available character.

"Okay, Karl, what do you think of this?" Marvin asked, holding up the finished sensor. "I used your 100-watt Weller soldering iron to solder the IR detector module to one end of this 8" brass rod, then hooked on the cable."

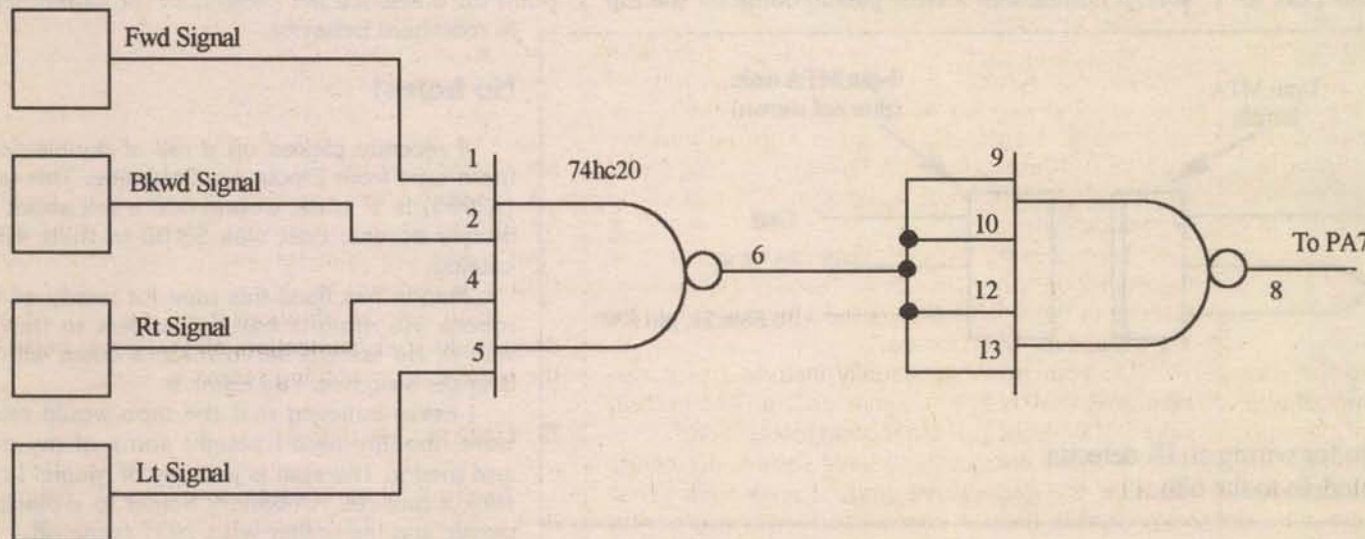
"Looks good," I said, "but how do you plan to mount it onto Max's

top platform?"

"Easy," he replied, "I've bent the last inch of the rod into a horizontal triangle, and I'll just blob some hot glue onto it and stick it onto that open spot on Max's board. Should hold just fine."

"Well, I've got the first cut of this control software written, so set Max up here on my desk and I'll try downloading the software into him." I hooked the serial cable into the connector on Max's computer board, then started the transfer using PCBUG11.

"Here's the control," said Marvin, offering me the unit. "What keys do what?"



Wiring four IR detector modules to produce a single output

input detects the selected edge. This lets your software count the number of times the PAI input goes to a specific level.

Note that either mode can be configured to generate a PAI interrupt when the PAI input changes to the specified state.

The PAI subsystem can generate interrupts on selected events, and whenever the eight-bit accumulator reaches \$ff. As with all 68hc11 subsystems, local masks can be used to enable or disable any combination of these interrupts.

I didn't really want to use either mode; I just wanted an interrupt when the PAI input saw a low-

gaps between pulses and Ls for long gaps. A quick check showed that my code wasn't matching up properly with his notes.

I found and fixed a couple of small bugs, and everything synced up beautifully. Now the BOTBoard software would help us plan the next step.

Software, round 2

"What's next?" Marvin asked, after we had satisfied ourselves that we had doped out the remote's transmission scheme.

"I picked out these four keys to do forward, backward, right, and left," I said, pointing to a diamond-shaped pattern in the center of the unit. "And this repeating key in the upper left corner is stop."

The software download finished, so I disconnected the serial cable, reset Max, and put it on the floor.

You could almost hear the drum roll. I pointed the control at Max, with its newly-acquired IR detector facing straight up. I pressed the key I had assigned to be forward, and Max obediently lurched forward. I was so shocked that the code actually worked that I forgot which key was stop, and Max slammed into the wall.

"This is great!" we both said at the same time. We took turns driving Max all over the upper floor of my house, using the remote control.

After about five minutes of enjoying our success, we both got a little more critical. "He moves way too fast to control easily with this thing," noted Marvin. "Yeah," I replied, "and we lose a lot of range because we have to use a bank shot off the ceiling to get the IR to his sensor."

I solved the first problem by editing the software to use different PWM values during turns and backing up. This made Max much easier to maneuver, but still left him with plenty of speed for the straightaways.

I wouldn't solve the second problem until after Marvin left for Portland. I used four IR detector modules, each wired to one input of a 74hc20 dual quad-input NAND gate. See the accompanying schematic.

The output of this first NAND gate is inverted by the second NAND gate. Its output is then hooked to the connector originally used by the first IR detector module.

This circuit generates a low-going pulse if any one or more IR detectors sees a signal. Essentially, I have built an IR detector with 360 degree vision.

A refinement — as yet untested — is to bring the output of each IR detector to an input port. The ISR software could then check this input port to

calls the double-decker version the B-BOT frame kit and sells it for \$29.95. The smaller unit, dubbed the B-BOT jr. kit, costs \$19.95. Be sure to contact Marvin about shipping costs and availability.

The B-BOT frame kits have quite a bit in common. I have a B-BOT frame to review, so I'll describe that. Remember that the jr. version only has one platform.

The B-BOT frame consists of two circles of 1/8" thick black plastic, precut to 5.5" diameters and drilled for assembly. The two circles bolt together using supplied 4-40 hardware and threaded spacers to form a two-tier platform about 1.25" high.

The lower platform has shaped cutouts, one on each side, to accommodate hobby-store wheels — that you supply — up to about 2.5" in diameter.

Marvin designed the frame kit to use two modified hobby R/C servo motors (not included), similar to the Futaba S148 units featured in earlier Amateur Robotics columns.

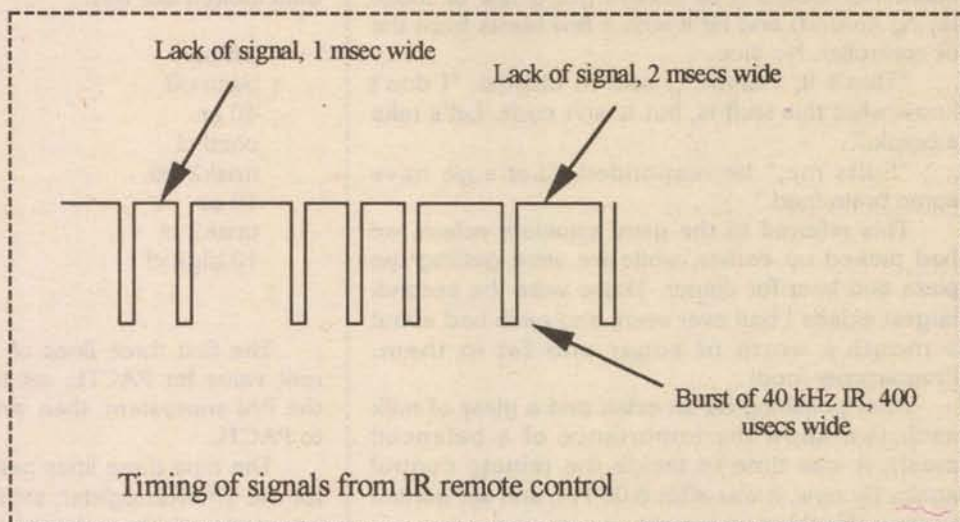
First, modify the motors so they turn 'round and 'round, then fasten them to the lower platform using double-sided foam tape or cable ties from the local hardware store.

Then, thread the servo's cables through the holes provided in the two platforms until the cables reach the top level. From here, you can plug the cables into the proper connectors on a BOTBoard (you supply), and you're just about ready to go.

The frame contains enough room for the BOTBoard and user-supplied batteries and sensors. It comes with a clear plastic dome for the top

in the plastic dome to mount it to the supplied angle brackets, and holes in the bumper skirt for threading the rubber bands.

I used double-sided foam tape to mount my sensors, battery holder, and the supplied bumper switches. If you don't use double-sided foam tape,



plan on drilling even more holes.

I made one change to Marvin's intended layout. I replaced his single large black drawer knob with two smaller red knobs, mounted front and back. The single knob would let the robot tip over backwards, even though the battery was mounted as far forward as possible.

I could have turned everything around, and put the large knob in back, but sooner or later the robot would have had to back up, and then it would have tipped over forwards.

The finished robot, named Arnold, has a very polished, professional look to it. The round dome, seamless bumper skirt, and smooth black plastic platforms give Arnold a touch of class. And Marvin's design is very well suited to cruising through the pitfalls and dangers in my living room.

This frame kit would make a great starting point for a science fair project, or for experiments in robo-herd behavior.

No holes!

I recently picked up a roll of double-sided foam tape from Electronic Goldmine. This tape (#3905) is 1" wide, wound into a roll about 10 inches across; cost was \$3.00 in their #222 catalog.

Marvin has used this tape for nearly all his robots. He mounts battery holders to frames with it. He fastens servo motors down with it. Bumper switches. You name it.

I never believed that the tape would really work, though, until I bought some of my own and tried it. The stuff is just shy of magic! I can stick a four-cell AA-battery holder to a piece of plastic and the holder WILL NOT come off.

I'm sold; I have already started using double-sided tape for all of my projects. Be sure to get the foam-type tape, such as Electronic Goldmine sells.

Mobile Robot kit

Speaking of kits, I also got an early look at the Mobile Robot kit, offered by AK Peters, Ltd., the publishing house that sells the book *Mobile Robots*. I reviewed the book several months ago, and recommend it without reservation to anyone interested in building small robots.

I want to make something clear from the first. This is not a kit for building a robot; this is a kit for building the electronics of a robot.

Some of the earlier advertisements were not

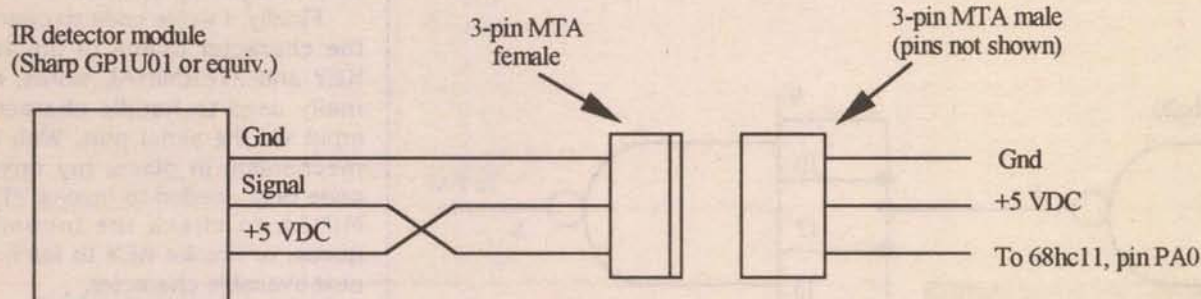


Diagram for wiring an IR detector module to the 68hc11

determine exactly which of the four IR detectors saw the signal.

This information, coupled with the character received, would enable Max to run some very sophisticated beacon contests, or to locate any object marked with an IR control such as these surplus units.

The B-BOT frame kit

Marvin's B-BOT robot frame kit (mentioned previously) is the latest addition to his line of simple, inexpensive robot projects.

He is selling two versions of the kit: one with two platforms stacked vertically, and another, smaller version with just a single platform. Marvin

and with a six-inch diameter plastic ring to serve as a bumper skirt.

Marvin designed his bumper skirt to hang from two rubber bands (included) and rest against three tiny microswitches (also included). The mechanics for holding this skirt in place are simple and elegant, and the skirt provides full coverage of the robot's perimeter. Properly adjusted, it can detect inward contact on any point on the outside of the ring's one-inch tall surface.

The kit also includes a black furniture knob and mounting hardware; the knob serves as a front skid for the robot.

Note that you will need to do quite a bit of drilling on this frame. You need to add holes in the top platform to mount your computer board, holes

clear on this point, and several people in the Seattle Robotics Society misunderstood what was being offered. So, I will describe in detail what arrived in my kit.

I received a partially assembled 68hc11a1 microcontroller board, complete with 32K of battery-backed static RAM. As it comes out of the box, this board supports RS-232 communications to a PC or Mac; you must specify which host you are using when you order your kit.

My review kit did not include a serial cable for connecting to my 386. The kit's instructions described how to build such a cable, though, and I had it done without too much hassle.

The kit came with a PC version of Interactive C (IC), a program development system created at MIT and used in — among other things — the 6.270 Robot Design class.

I plugged in the serial cable, hooked up 6 VDC to the board, and turned on the power. I was immediately able to download the required portions of IC. I could then download and run several of the provided test programs, including a cute routine for playing a tune on the board's piezo speaker.

As of this writing, I have wired about 50% of the board, using the supplied sockets and parts. This kit was designed by several people involved with the original *Mobile Robots* book and its Rug Warrior robot, so the design is well done and the board goes together easily.

One nice feature is the on-board LCD. My kit was supposed to have the 16 character by two line display, but instead had a note indicating that the display would be shipped separately. So, I grabbed a spare LCD from my junk drawer and plugged it into the on-board connector.

With the LCD in place, IC displays its initial sign-on text, as well as a little heart-shaped character that "beats" to show the 68hc11 is alive.

The kit comes with an assembly guide that describes how to use IC, as well as providing details on debugging, operation, and assembly instructions.

When fully constructed, this board provides support for bumper switches, an IR object detector circuit, a cadmium-sulfide photocell for light-level detection, and a microphone for checking ambient noise level.

The board also features a 754410 dual H-bridge motor driver IC, for running two DC motors at up to 1 amp current drain. This is a bipolar driver chip, so the motors you hook up will receive

about two volts less than the motor battery voltage, owing to the voltage drop inside the IC.

Though the assembly guide is fairly complete, you will really want a copy of *Mobile Robots* nearby to get the most from this kit. The supplied assembly guide is more of a technical reference manual; the book will help you expand your kit and learn how it works inside.

I haven't had the kit running long enough to really wail on IC. I do know that this is a very mature system, having been through several years of testing "under fire" in the MIT robot classes. IC offers a multi-tasking system, floating-point support, and an interactive environment for writing robot software right on your machine. I am really looking forward to using it.

AK Peters, Ltd., is selling the Mobile Robot electronics kit for \$289.95; you can contact the company directly at the address and phone number provided.

I consider this a good price for what you get. Sure, you can buy general-purpose 68hc11 single-board computers (SBCs) for less, but an SBC does not a robot make.

Besides the computer and memory, this electronics kit includes tested designs for motor control and sensor circuitry; design elements that have broken the spirit of more than one robo-hacker.

The board is compact, measuring only 4.5 x 3.5 inches. It is well laid out, complete with silk-screened legends for mounting components and labeling sockets. And the array of connectors means you can easily add or rearrange external devices.

The IC system, customized for this board, creates a powerful combination. Software already designed to work with well-crafted hardware means you can focus on writing your robo-code, not figuring out why the two elements don't work together properly.

Naturally, I found a few nits to pick about this kit. I would like to see a pre-built serial cable made available, perhaps at a slight additional cost. And I really, really wish the authors would include pin numbers on all of their schematics! Not that I expect to have to trace anything out, but if I did, the supplied schematics are almost useless for debugging.

Note that you do not (as of this writing) get a base, motors, wheels, or hardware for mounting your finished board. You also do not get even a rudimentary program for a robot, though you get a

good library of self-test programs.

Some SRS members thought \$289.95 was too much to pay for a kit that didn't include a motorized base. On the one hand, I can see their point. If you are building this for a child's science fair project, or if you are on a student's budget, the cost may be prohibitive.

On the other hand, a scaled-down version of Max, my latest robot base described in the last several columns, should only cost between \$50.00 and \$100.00, depending on how fancy you want to get. And you can probably trim that down quite a bit if your junk box is well-stocked.

The gripping hand is that the board's designers have solved nearly all the tough robot design problems for you, and packaged it up in one small board and one floppy disc. Add in the *Mobile Robots* book, filled with closely related information, and you have an unbeatable combination.

As of now, this kit is by far the best method of building the electronics for your own medium-sized custom robot that I have seen.

The design team for this kit includes Joe Jones and Anita Flynn, authors of the *Mobile Robots* book. It also includes Randy Sargent and Fred Martin, who helped originate the 6.270 Robot Design contest and the IC programming environment. **NV**

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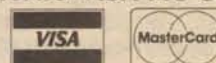
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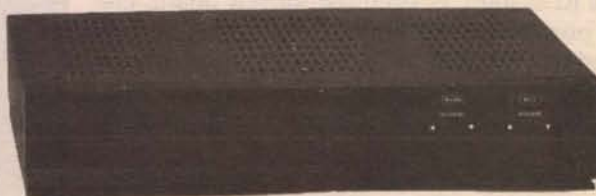
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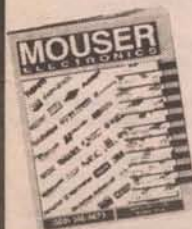
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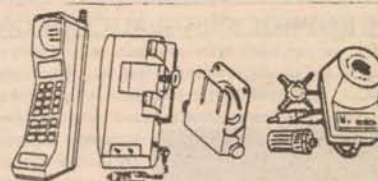
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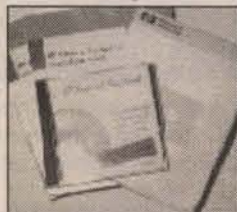
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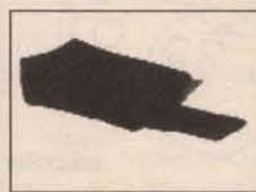
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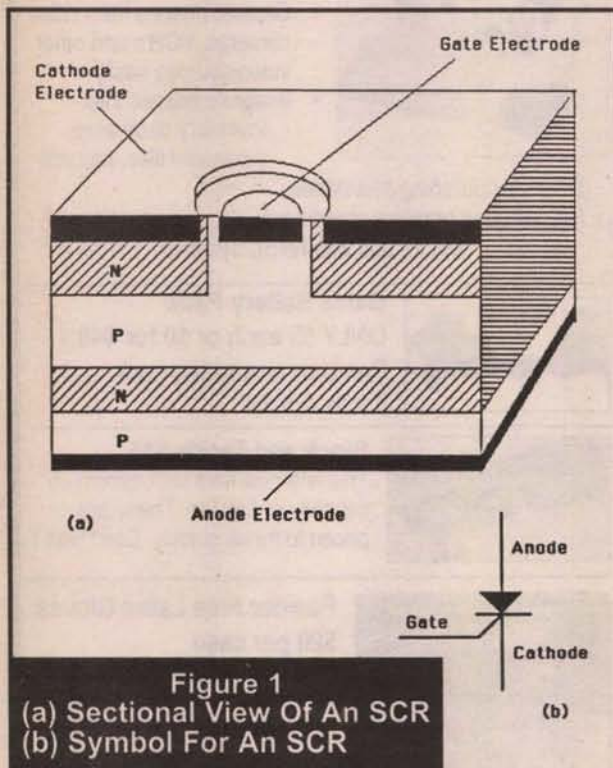
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THE SOLDERLESS BREADBOX

by Donald Wilcher



SCR Basics

In this month's column, we are going to take a look at a unique semiconductor device known as the SCR.

The SCR or silicon controlled rectifier is a three-terminal device capable of controlling large amounts of current in an electric circuit.

The SCR, since its conception in 1960, has been used in a lot of industrial control applications. For example, they can be found in lighting control panels, motor speed control circuits, electric welding applications, and as simple as electric heating.

The SCR was developed so that it could reduce the amount of wasted energy, as well as maintenance cost related to using heavy devices such as transformers and rheostats.

One unique aspect of the SCR is its ability to latch an external load. The reason I say this is that with other control devices, the circuit must remain in the "on" position, whereby in the SCR circuit, by applying a small amount of current to the gate circuit of the SCR, it puts it into a solid-state latching or memory mode.

Some of the examples in this column that we are going to take a look at are, of course, the latching capabilities of the SCR, as well as the internal construction of the SCR based on its physical structure. And, as usual, there will be a couple of hands-on circuits for those hackers who are interested in getting some first-hand experience in using this fascinating device. So, without further delay, let's examine the SCR's physical make-up.

THE PHYSICAL STRUCTURE OF AN SCR

Basically, an SCR is a four-layer PNP unidirectional device used for bistable switching. The

SCR has three junctions and three terminals: It has an anode, cathode, and gate. Figure 1 shows the schematic of the SCR and a sectional view of an SCR chip showing layers and junctions.

The SCR is an ordinary rectifier diode with a control element — the gate. Current to the gate determines the anode or cathode voltage of which the device begins to conduct.

The gate bias can keep the device off or it can permit electrical conduction to begin at any desired point in the four half cycles of an alternating current across the anode and cathode terminals.

The SCR is turned on by placing a positive voltage on the gate electrode. Once turned on, the SCR remains on even if the gate voltage is cut off or made negative.

The anode or cathode voltage must be reduced to a low level ($< 0.6V$) or forward current must be reversed. Also, if it is an AC circuit, the AC signal must cross the zero level.

The SCR is most often used to

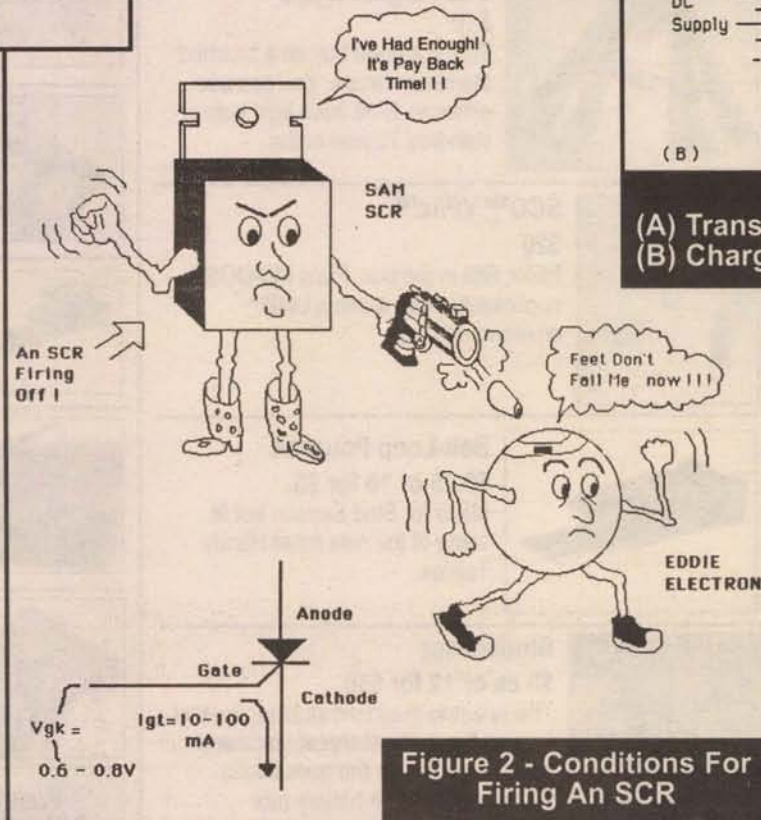


Figure 2 - Conditions For Firing An SCR

switch currents in one direction only, making it useful for DC and halfwave AC circuits.

SCRs can function as control rectifiers and bridges. They can handle hundreds of amperes and peak voltages to 15 kilovolts with triggering currents of less than a few milliamperes. However, most SCRs used in electronic-related applications are rated 40 amperes or less.

The gate turn-off is a variation of the SCR design to permit it to be turned off with a negative bias from the gate terminal.

SCRs are packaged in the same style case as other power semiconductor devices.

Now that we have an understanding of the physical structure of the SCR, we can now take a look at the SCR gate characteristics.

SCR GATE CHARACTERISTICS

An SCR is fired by a short burst of current into the gate. This gate current flows through the junction between the gate and cathode and leaves from the SCR on the cathode lead.

The amount of gate current needed to fire a particular SCR is symbolized by I_{gt} . Most SCRs require gate current between 10 and 100 mil-

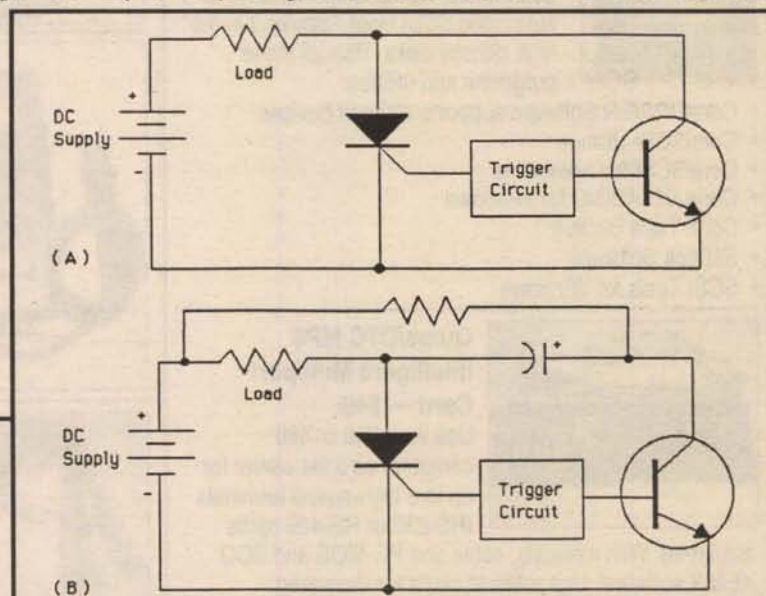


Figure 3

(A) Transistor Switch Shorts Out SCR
(B) Charge Capacitor Reverse Bias SCR For Turn-Off

liamperes to fire ($I_{gt} = 10-100$ milliamperes). Since there is a standard pn junction between the gate and cathode, the voltage between these terminals must be slightly greater than 0.6 volts.

Figure 2 shows the condition which must exist at the gate for an SCR to fire. Once an SCR has fired, it is not necessary to have full gate current as long as electrons continue to flow through the main terminals — the anode and the cathode.

When the anode-to-cathode current drops below some minimal value called holding current (symbolized I_{hg}), the SCR will shut off. This condition normally occurs as the AC supply voltage passes through zero in its negative region for most medium-sized SCRs. I_{hg} at this point is around 10 milliamperes. With this unique characteristic as mentioned before, the SCR is capable of performing as a latching control circuit.

Now, we will look at how SCRs are used in DC circuits. Bear in mind that the examples shown in the figures are by no means complete, but they do highlight the key characteristics — the ability to latch or control current flow to the external load.

SCRs IN DC CIRCUITS

When an SCR is used in a DC circuit, the automatic turn-off does not occur because of the supply voltage not passing through zero. In this situation, some other means must be used to stop the SCR main terminal current.

One obvious method is to simply disconnect the DC supply. In most cases, this is impractical. Often, main terminal current is stopped by connecting a temporary short circuit from the anode to the cathode.

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This is illustrated in Figure 3A, in which a transistor switch is connected across the SCR. When the SCR is to be turned off, the trigger circuit pulses the transistor causing the SCR main terminal current to drop in. This transistor is held on long enough to turn off the SCR. This normally takes a few milliseconds for a medium-sized SCR.

The trigger circuit then removes the base current, shutting the transistor off before it can be destroyed by the large flow current.

In this arrangement, the trigger circuit is responsible for both turning on and off the SCR. Such trigger circuits are naturally more complex than those discussed.

A more reliable turn-off can be accomplished by actually reverse biasing the SCR. This is shown in Figure 3B.

In this circuit, the capacitor charges with the polarity indicated when the SCR is turned on. To turn off the trigger circuit, the transistor effectively places the capacitor in parallel with the SCR. Since the capacitor voltage can not change instantly, it applies a temporary reverse voltage across the SCR shutting it off.

Another name used to describe this operation is known as the "crowbar." With the crowbar circuit — as the name implies — it slams the SCR to the turn-off mode by shorting out the anode and cathode terminals via the transistor. And, as discussed in this paragraph, one can see why the name crowbar was given because it is as though someone is taking a crowbar and putting it across the plus and minus terminals of the voltage source, thus stopping the flow of current through the anode and cathode leads.

With a basic understanding of the SCR's physical make-up and its basic characteristics, let's have some fun by breadboarding a couple of circuits. I enjoyed building these circuits and I hope you electronic hackers will have the same type of fun.

The circuits to be discussed are a Silent Burglar Alarm and a Light-Activated Latching Relay. So, let's begin our discussion with the operation of a Light-Activated Latching Relay.

LIGHT-ACTIVATED LATCHING RELAY

As shown in Figure 4, the schematic diagram illustrates how the SCR can be used to control an external load. Basically, this circuit is not that complicated in design. It consists of a voltage divider network made up of a photocell and a 50K-ohm potentiometer, and that circuit is tied to the SCR latching circuit via the 100-ohm resistor.

The operation is such that when light shines upon the photocell, a voltage is established across

the 50K-ohm resistor which will allow current to flow through the 100 ohm resistor.

Now, bear in mind the voltage across the 50K-ohm potentiometer is greater than 0.6 volts and that's needed to get the SCR to its conducting mode. If the voltage is greater than 0.6 volts being applied at the 100-ohm resistor, the SCR begins to conduct, thereby energizing the relay.

Now, if light continues to shine on the photocell, the SCR circuit will not respond due to its latching characteristics and, therefore, will keep the relay energized until the reset push button is depressed. By doing that, a current flow will not be established and the relay's coil will be de-energized, therefore turning off the external load which is connected by the contacts of the relay.

The unique thing about this circuit is its ability to turn on a device via a light source and keep that device turned on until the reset push button is depressed.

One fascinating application this circuit can be used for is a crash avoidance system, whereby a truck or car backing up against a building with the rear tail lights illuminated, will shine on the photocell, thereby turning on the latching circuit via the SCR.

because of one power supply instead of two.

THE SILENT BURGLAR ALARM

The silent burglar alarm is shown in Figure 6. The reason for calling it a silent burglar alarm is

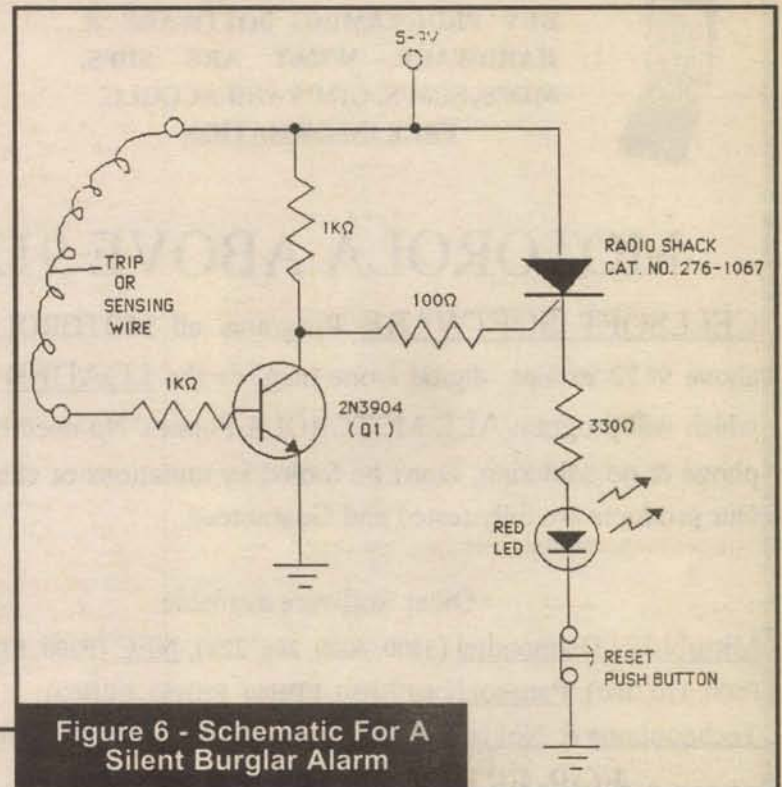


Figure 6 - Schematic For A Silent Burglar Alarm

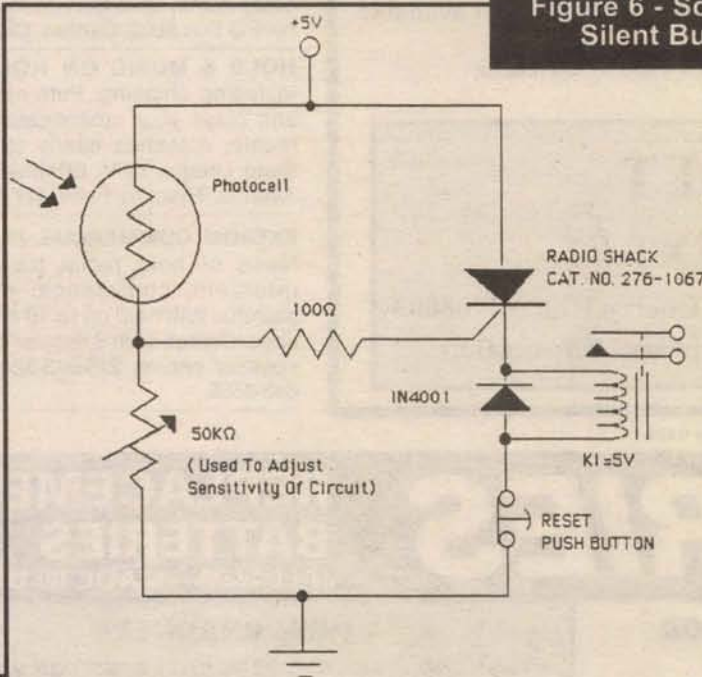


Figure 5 - Light-Activated Latching Relay Using Single 5V Power Supply

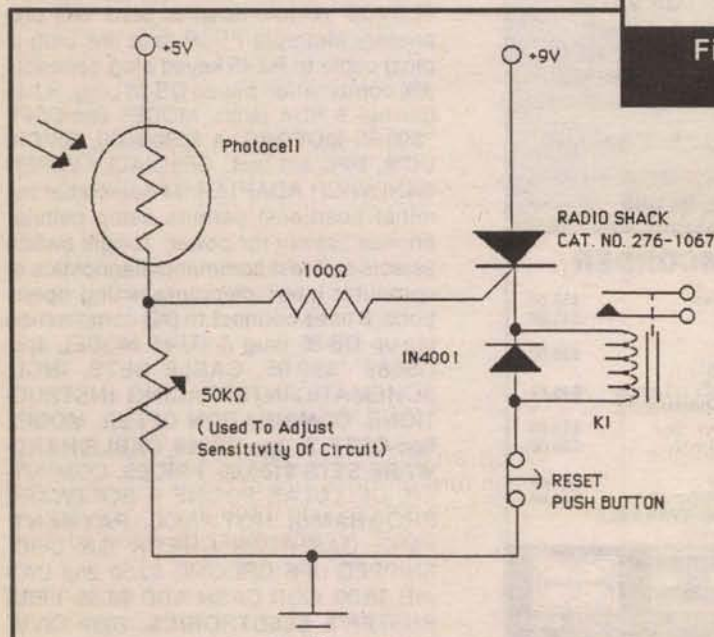


Figure 4 - A Light-Activated Latching Relay

But the restriction is the fact that the light shining from the truck or car tail lamps must be within a certain distance in order for it to activate the warning system. So, if the vehicle is not within the target limits of the sensor, the alarm will not be activated.

One thing about this circuit is the fact it has two separate power supplies. It has a five-volt source for the photocell circuit and a nine-volt source for the latching circuit. One way to optimize or modify the circuit where one voltage can be used is to select the appropriate rated relay as shown in Figure 5.

Instead of using two separate voltages, the circuit has been modified to operate off of five volts because of the five-volt relay being used in the latching circuit. So, this selection of the relay makes the design more compact

that an LED is used to indicate that an intruder is present.

The operation of this simple, silent burglar alarm is such that if the trip or sensing wire is broken, transistor Q1 will be off, thereby activating the SCR alarm circuit.

The transistor Q1 is configured as an inverting device, where if an input voltage is applied to the base circuit via the 1K-ohm resistor, the output would be zero.

So, by looking at the circuit, what we have is basically the transistor being turned on and the output being zero volts thus, the inverting operation of the transistor is keeping the SCR circuit off. But by removing the trip or sensing wire, this allows current to flow through the 1K-ohm resistor of the transistor's collector circuit, thereby establishing the gate trigger current necessary to turn on the SCR, thus illuminating the LED circuit.

As a design challenge, instead of using an LED for the alarm, try using a piezo alarm in its place. This device will then provide an audible alert detection circuit.

FURTHER THOUGHTS AND EXPERIMENTATION

Well, it is hoped that the information discussed will show how unique the SCR is and its capabilities to latch DC circuits. Although the focus of this discussion was on the DC applications, the SCR can be used to control large currents in AC circuits, but the philosophy behind this column is to keep it simple and safe and that is why AC circuits were not highlighted.

One item that could be tried as an experiment is to take the latching circuit of the SCR and tie it to a computer, whereby a switch closure is made and that closure will go through a small BASIC program which will then send the appropriate voltage to turn on the SCR circuit, thereby latching the external load like a motor or a lamp.

This challenge will be discussed in a future column. Enuf said, see ya next month in the Breadbox! NV

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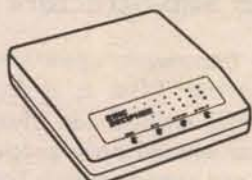
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Telerobotic Systems

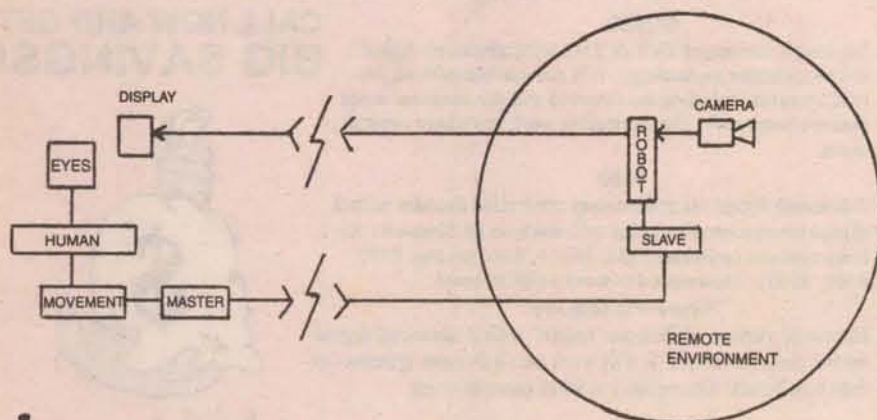
In this article, we will build a telepresence robot (T-Bot). Telepresence robots are planned for use in a variety of scientific, entertainment, business, military, exploratory, and industrial applications. T-Bots can be made for a few thousand dollars that rival simulations currently costing hundreds of thousands, if not millions of dollars.

What's in a Name?

The late science fiction (SF) writer Robert Heinlein is credited as the first person to predict the use of telepresence robots in his 1940 SF novel titled *Waldo*. In the story, a human operates mechanical puppets (called "waldos") to do his bidding

system are the same as used in virtual reality (VR). Figure 1 illustrates a basic telepresence system.

In virtual reality, we achieve immersion into a synthetic computer generated environment by fooling our senses, as best as we can, to believe in and interact with the computer synthesized environment.



from a remote location.

Rather than use the term waldo, I found the word golem from Yiddish mythology more suitable. The story of the golem describes the intentional placing of a human spirit in a clay figure. The spirit controls the clay figure to do its bidding, which it would not or could not do in its human form. Once the golem's work was finished, the spirit returns to its human form. This definition adequately describes the new science of telepresence. I therefore have named my first telepresence robot Golem I.

What is Telepresence?

Telepresence is a high fidelity form of remote control that projects the senses of the human operator into a robot at a distant site. The interfaces used to create a telepresence

system are the same as used in virtual reality (VR). Figure 1 illustrates a basic telepresence system. In virtual reality, we achieve immersion into a synthetic computer generated environment by fooling our senses, as best as we can, to believe in and interact with the computer synthesized environment.

On the human side, as stated before, the same VR equipment is used to fool our senses into believing that the environment is real. In this case, however, our immersion (presence) is at the remote location of the robot.

Different levels of presence are achieved depending upon the fidelity of the interfacing devices. A humanoid robot that could accurately follow human movement, gestures, locomotion, and balance, while providing visual, thermal, tactile, and force reflection over its entire exoskeleton to the human operator would

be a perfect golem. The illusion created is that the operator has merged or is contained within the robot structure.

Current telepresence systems fall quite short of this goal. In most cases, however, the remote robot is a vehicle — like the one we shall build. The best telepresence existence available with these rudimentary T-Bots is to believe one is actually driving the vehicle from inside. This is the telepresence we are striving for.

T-Bots can be built to explore and operate in harsh or hazardous environments. A partial list of remote environments includes arctic underwater diving, ocean floor rover, forest fire, active volcanos, nuclear reactor, the moon, Mars, or anything in between.

System Sub-Structure

The framework upon which we will build our T-Bot is a radio-controlled (RC) electric car. Ideally, the model car should have proportional steering and speed control. This is the type of model used in building the prototype. A less expensive RC model may be used, but you won't have as much control when driving.

Figure 2 is a photograph of the RC model car. It has a spring suspension system. The suspension system can be incorporated with a sensor system to provide a feel of the terrain. But we are getting ahead of ourselves.

Purchase an RC car that is bundled with a battery charger and rechargeable batteries. With some RC

models, these items must be purchased separately.

A Little on RC Models

Radio-controlled models have evolved into a popular hobby. There are radio-controlled airplanes, helicopters, gliders, power boats, submarines, cars, motorcycles, etc. Most models are suitable shells and springboards for golem-type robots.

Not long ago, RC models were exclusively gas powered. In the late '70s, improvements in battery technology and electric motors made electric-powered vehicles a viable option.

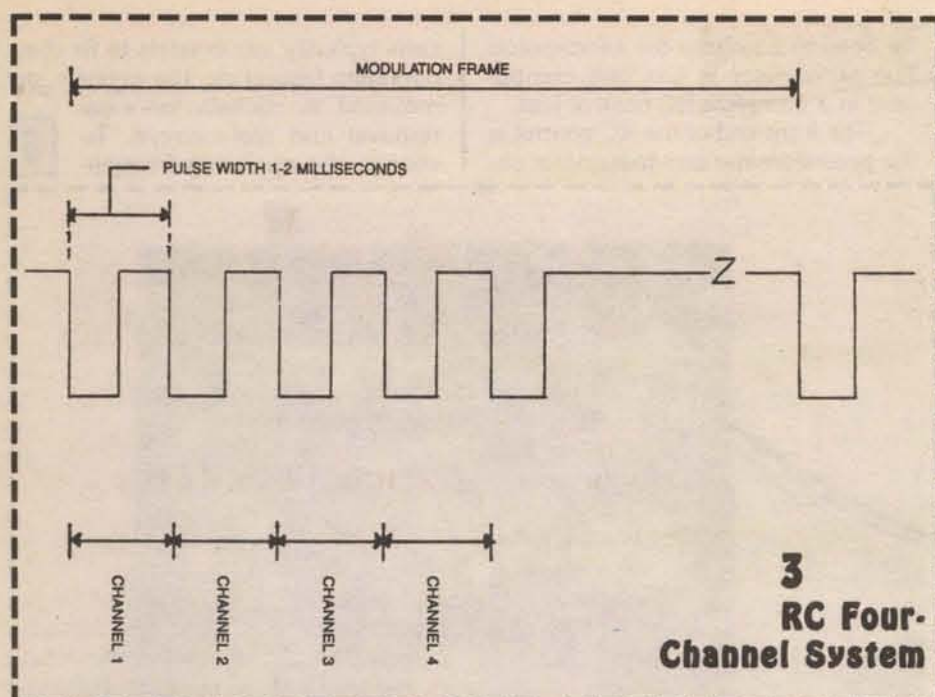
Model cars are typically controlled from a two-channel radio. One channel controls steering and the other throttle. Each channel is controlled by a potentiometer inside the transmitter. The steering potentiometer is often connected to a small steering wheel on the transmitter control. The throttle is usually connected to a trigger or stick.

An encoder chip in the transmitter modulates a pulse-width on the transmitter's carrier signal. The pulse-width is based on the position (resistance) of the potentiometer's shaft. The pulse-widths are varied between 1 and 2 milliseconds (ms) (Figure 3).

When the potentiometer is in its center position, the pulse width corresponding to that channel is 1.5 milliseconds. When the control is pushed to one extreme, the pulse width increases to 2 ms. When pushed to the opposite extreme, the pulse-width shrinks to 1 ms.

The receiver decodes the pulses on the carrier signal and sends them to their respective servomotors. The servomotor is an





integral unit, containing a motor, gearbox, output shaft, and a PC board.

The PC board on the inside of the servomotor generates a reference pulse that is based on the position of an internal potentiometer connected to the output shaft.

A decoder chip on the internal PC board compares the incoming pulses from the receiver to the reference pulses. The servomotor attempts to match the pulse-widths of the two signals by adjusting the position of the servomotor's output shaft. This is how the servomotor tracks and holds its position based on the signal from the transmitter.

Eyes

The eye(s) for our T-Bot is a microminiature video camera (Figure 4). The B/W camera cost is approximately \$200.00. Color versions are available for \$150.00 more, and are well worth the additional money if your pocketbook can afford it.

The overall size of the camera is quite small. So small, in fact, that two video cameras may be mounted side by side and have the approximate IPD of 63 mm

between lenses. Mounting a pair of cameras like this will enable the T-Bot to transmit realistic stereo pictures to the operator.

For the prototype, we will use just one camera. Later, we will discuss improvements to the system that will add stereo-vision to provide depth perception to improve telepresence and operation.

The prototype T-Bot contains a single microminiature video camera. As with the head-mounted display (HMD), the T-Bot subsystems are built in modular form. Therefore, if the reader wishes to create a stereo system in the future for the T-Bot, all video components are reusable.

Head Tracking

Although eye tracking is still too difficult to easily incorporate in an HMD, we can provide head tracking. Head tracking will allow the video camera to turn in synchronization with head rotation. This allows the operator the freedom to look to the sides while driving the model car.

No facilities are being incorporated for tilt (up and down). Although adding tilt is possible, it adds complexity to the servo mechanism

design. Interested readers can employ the same type of servo system used for rotation to incorporate tilt.

Construction

Construction of the T-Bot begins by analyzing the chassis of the model car. Most RC model cars have an outer cosmetic shell that makes the model look like a standard vehicle: car, truck, Landrover, etc. Remove the outer cosmetic shell of the RC model. Secure the equipment directly onto the chassis.

The Golem I needs three separate power supplies — one each for the video camera, video/sound transmitter, and servo motor. Both camera and transmitter each use a 12-volt battery power supply made from eight AA batteries. The servomotor with receiver module uses a 6-volt power supply.

Although it may be possible to supply both the camera and receiver from a single 12-volt supply, this will deplete the batteries too quickly, making the T-Bot run-time short.

When purchasing the AA battery compartments, make sure they are the type that have the terminals for a

Video Transmitter

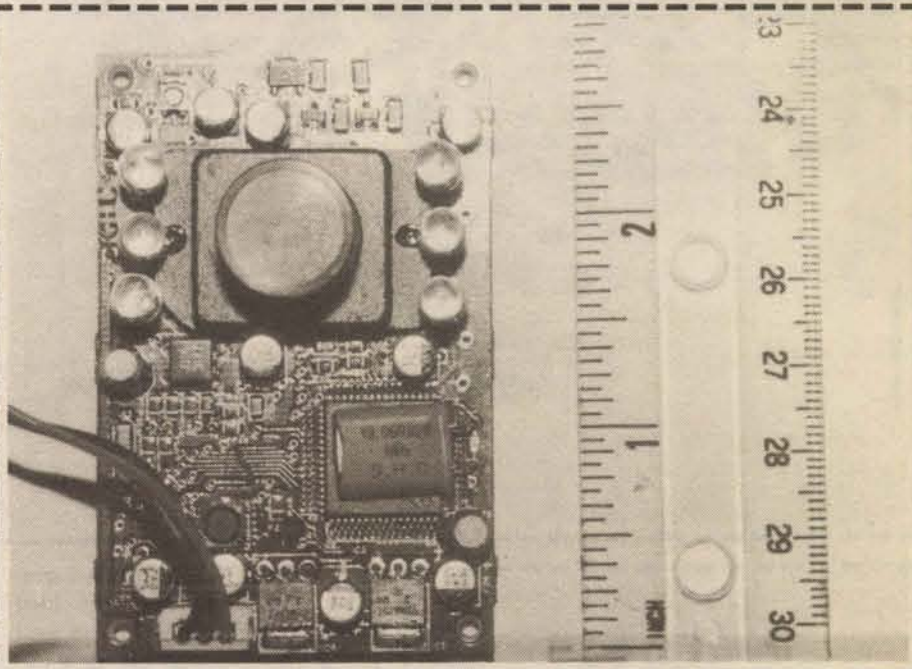
The video transmitter is a kit available from Images Co. (Figure 6). Put the kit together according to the instructions supplied. Before tuning the transmitter to Channel 3 or 4 we need to make two simple modifications to improve its performance.

The first modification on the video transmitter is the power supply. The transmitter is supposed to run using a single 9-volt battery. A single 9-volt battery power supply is too weak to operate the transmitter to specification. Instead, use a 12-volt battery supply made from eight AA batteries.

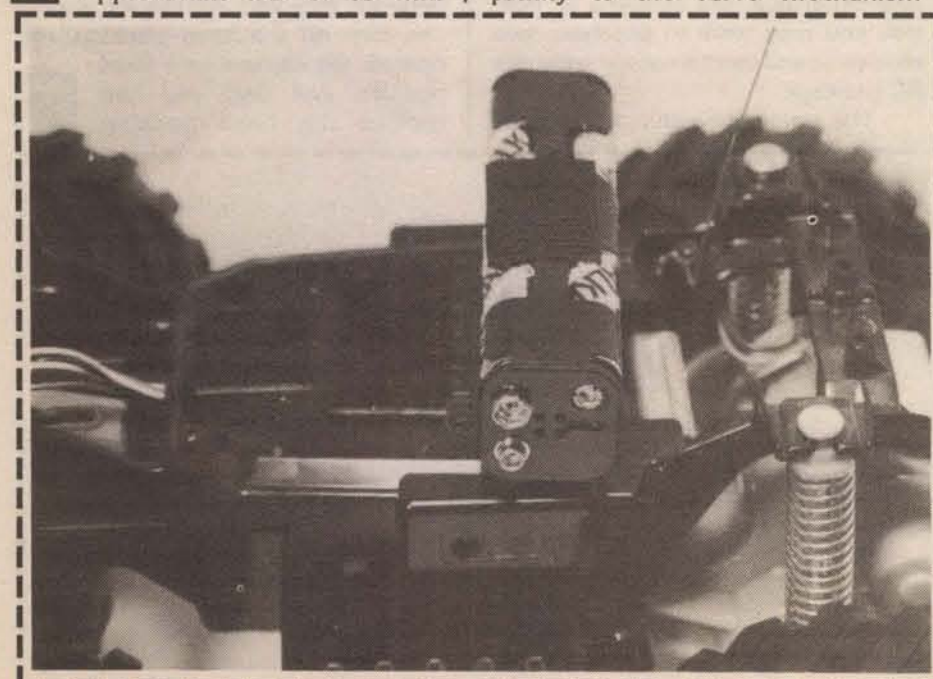
The second modification calls for placing a 75-ohm 1/4-watt resistor on the transmitter output. The 75-ohm resistor is placed on the solder side of the PC board. Solder one end of the resistor to the antenna pad and the other end to a circuit ground pad.

Figure 7 illustrates the proper placement of the resistor. Notice in the picture that there are two resistors shown. The reason for this is that I didn't have a 75-ohm resistor in my parts bin. I therefore used two 150-ohm resistors in parallel which is equal to a single 75-

4



5



standard 9-volt snap-on battery clip. This will reduce the amount of soldered wires and simplify construction.

To keep the component mounting simple and modular, we will make liberal use of Velcro™ material. Velcro material is typically sold in strips, by foot increments. The velcro strip is made of two mating strips of material that adhere to one another. Each strip has self-adhesive on the back. The Velcro material is mounted to the chassis with the mating strip placed on the component to be mounted.

The battery supplies are mounted to the car using Velcro. This allows for easy removal of the battery packs from the car to replace worn out batteries. Velcro is used on top of the battery compartments for mounting the video transmitter (Figure 5).

ohm resistor.

After making these two modifications, tune the transmitter according to the directions supplied with the kit.

Mounting the Video Transmitter

In the prototype, the video transmitter is secured on top of the batteries using Velcro. The 9-volt battery holder on the transmitter PC board is not needed to hold a battery. However, it makes an excellent location to secure the servo motor and/or video camera.

Miniature Video Camera

The miniature video camera does not require construction. It is a finished product and may be used as it's received. The camera has three wires

coming out of it to connect power and output the video signal (Figure 8).

The experimenter needs to supply power to the camera and make a suitable mounting bracket to hold the camera onto the golem robot. The video-out from the camera goes directly to the video-in of the video transmitter.

Mounting the Video Camera

There are two options regarding the mounting of the video camera. You can start out with a fixed camera position or it can be mounted on top of a servomotor for head tracking. The servomotor is naturally more complex and requires the building of a head tracking unit. You may want to try the fixed position first, to keep the construction simple.

Fixed Mounting

Whether you use fixed or servo mounting, you need a small bracket to secure the camera to the chassis. The bracket is made from a small piece of 1/16"

thick transparent plastic (Figure 9).

The plastic is heated gently over a low flame until it softens enough to bend one end 90 degrees. If the plastic begins to bubble or catch fire, it's too close to the flame. Get a piece of scrap wood, a 2 x 4 works well. We will bend the softened plastic over the wood's corner to make the 90-degree bend.

Put on an oven mitt on the hand that will bend the plastic. Scratch or mark the end of the plastic approximately where you want to place the bend. Hold the opposite end with pliers. Hold the plastic over a low gas flame using the pliers until the plastic softens. Move the plastic horizontally over the flame so that the entire side softens and not just a section.

When the plastic is soft, remove it from the flame and place it on the 2 x 4 lumber. Align your mark so that it is over the edge of the wood. Using your mitten-covered hand, press down on the plastic creating the 90-degree bend. Allow the plastic to cool completely before doing any further work.

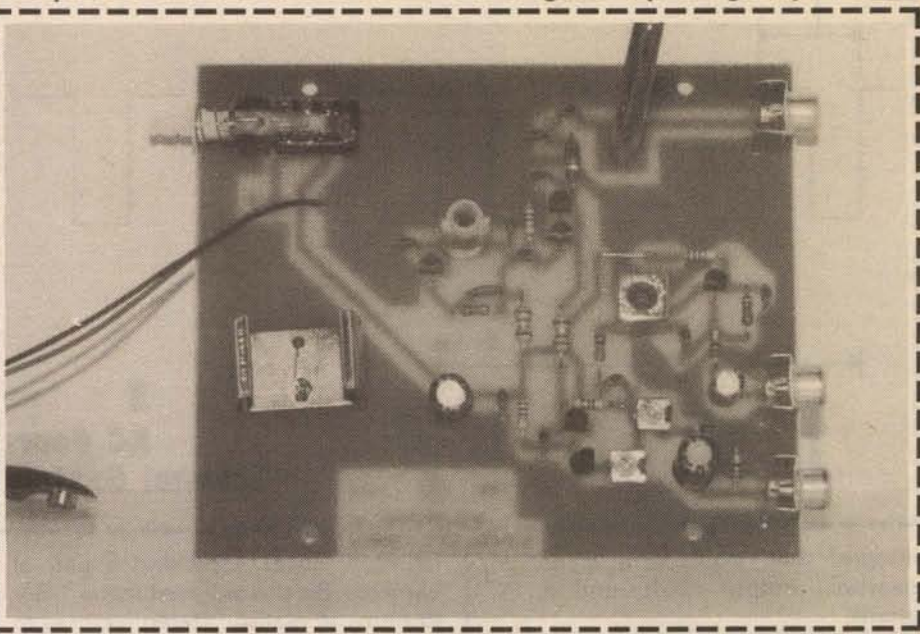
The corners of the camera's PC board have four small holes suitable for mounting the camera. Hold the PC

we need to purchase the servomotor. The servomotor is just one component in a complete RC control unit.

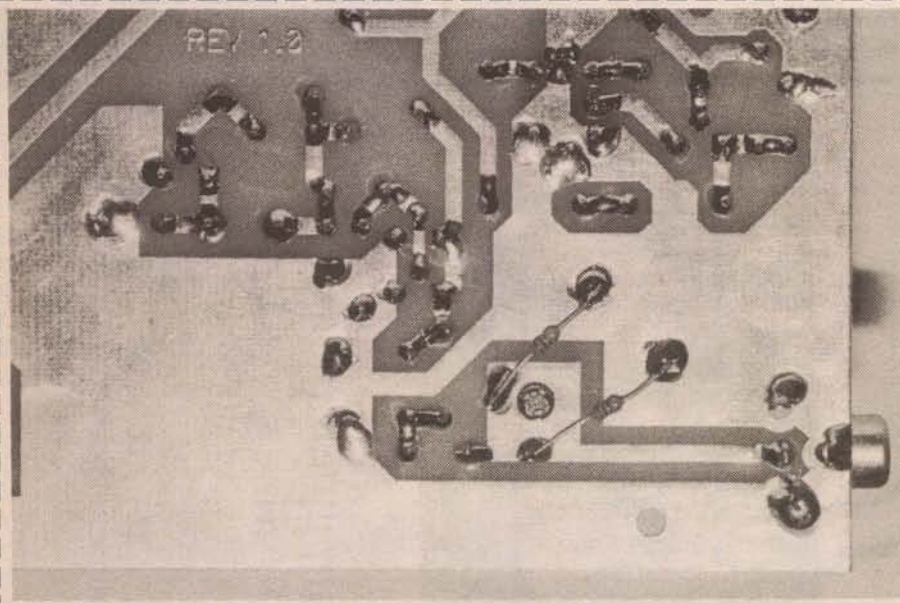
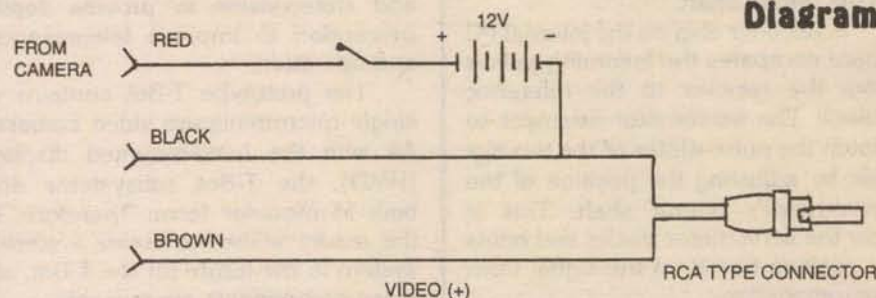
The front end of the RC control is the potentiometer and transmitter cir-

cuits typically use crystals to fix their operating frequency. The crystals are mounted in sockets for easy removal and replacement. To change the operating frequen-

6



8 Camera Wiring Diagram



cuit. The back end is placed on the model car and consists of the receiver and servomotor.

RC controls are usually sold as a complete unit, so the transmitter and receiver frequencies match.

Typically, the transmitter has two or more channels. Each channel can control a separate servomotor. We only need one channel for our basic T-Bot. However, if you expect to do a little expansion, like adding a tilt control, you may want to purchase two receivers and servomotors with the RC package.

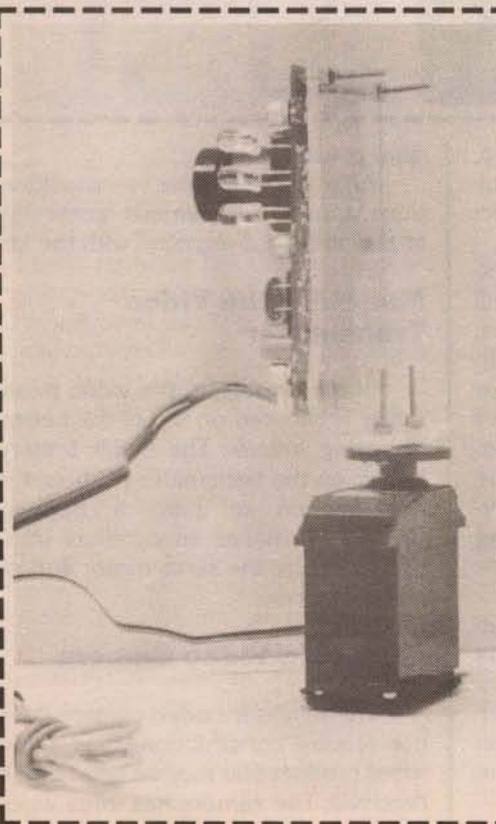
The transmitter and receiver cir-

cuit becomes a simple matter of changing the crystals.

When purchasing the RC control, compare the operating frequency of the unit to the frequency of the RC car. They should not be the same. If both operate on the same or close frequencies, you may get some cross talk between receivers that will render the vehicle inoperative.

If cross talk should happen between receivers on the RC model car, turn off the head tracking and operate the camera as a fixed position unit until you can replace the head tracking

10



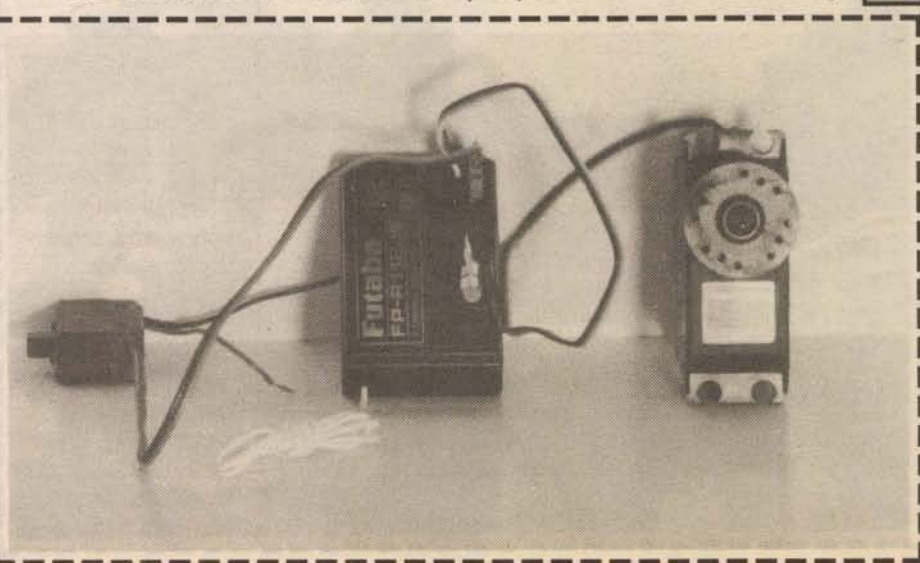
board to the plastic bracket and mark the position of the four holes. Remove the camera and using an .065 drill bit, drill the four holes. A .065 drill bit is commonly used to drill holes in PC boards. Mount the camera to the bracket using four #0-80 machine screws and nuts.

Drill two small holes on the bottom of the plastic bracket. Find a suitable place on the model car's chassis to mount the bracket, then drill two matching holes. Use the bracket holes as a template to insure accurately lining up the holes. Mount the bracket to the chassis using machine screws and nuts.

After the bracket is attached to the chassis. Mount the video camera to the bracket using the 0-80 machine screws and nuts.

RC Servo Mounting

Before we can mount the camera to a servomotor,



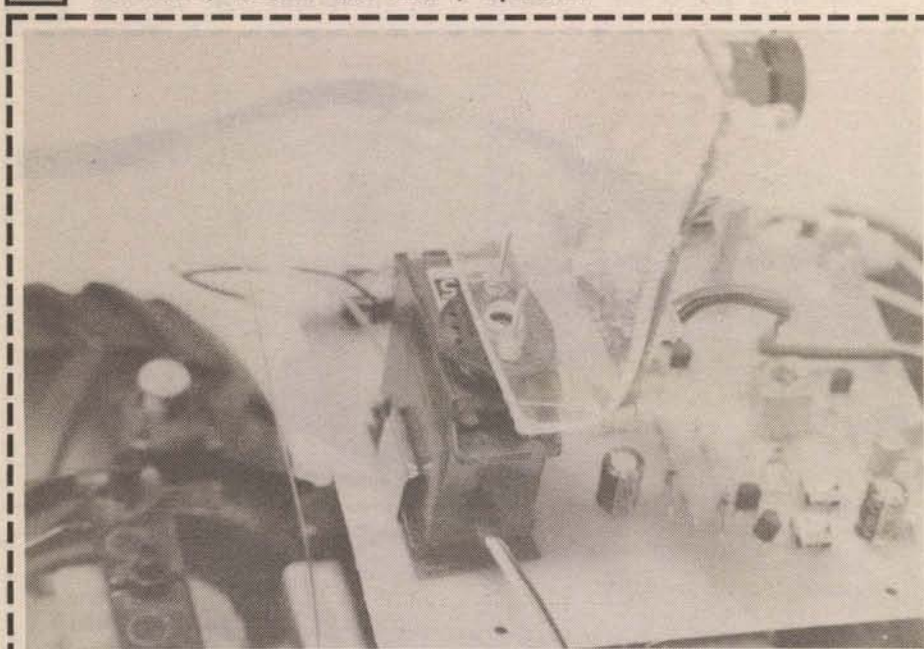
unit's crystals.

A typical receiver with its servomotor is shown in Figure 10. The top of the servomotor has a circular disk that is used for standard model RC controls. This disk can be removed to work on it; take out the center screw and pull up on the disk.

To mount the camera to the servo, remove the disk

kept simple by using off-the-shelf components instead of hand-building. The head-tracking arm is made from a standard lamp fixture (Figure 12). This fixture has moveable spring loaded joints allowing the operator to move their head more freely. The base of the lamp can be easily connected to a shelf or desk top near the operator.

11



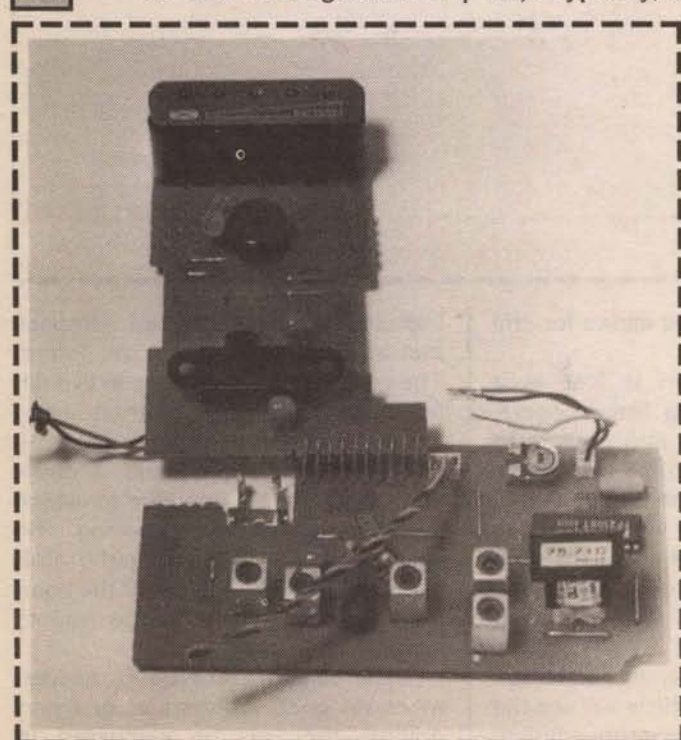
from the motor. Use the disk as a template to drill two holes in the bottom of the plastic camera bracket. Secure the bracket to the disk using two #0-80 screws and nuts. Re-attach the disk to the servomotor and replace the center screw to the disk.

The servomotor camera assembly may be positioned anywhere you like on the model car. One location you may want to try is the unused 9-volt battery bracket on the transmitter circuit board. Secure a piece of Velcro to the bottom on the battery holder. Place the matching piece of Velcro on the base of the servomotor. Then, insert the servomotor video camera assembly into the battery holder (Figure 11).

Head-Tracking Device

14

The head-tracking device is



Before beginning construction, it's a good idea to check the RC unit out first to insure that it is in good working order. As stated previously, transmitters usually have two or more RC control channels. Put batteries into the transmitter and apply 6 volts to the receiver circuit.

Since we only need one servo on the golem, find out which control stick controls the channel the servomotor receiver is tuned to. Mark that controller stick.

Servomotors have approximately 90 degrees rotation. By moving the control stick back and forth, the servo should rotate left to right in proportion.

Construction of the head-tracking unit begins by disassembling the transmitter of the RC control (Figure 13). Typically, there are two poten-

tiometers (pots) in the transmitter control. We only need to remove the pot that controls the servomotor. Leave the other one in place.

The potentiometers are usually held in a gimbal housing by one set screw on the shaft. Loosen the set screw and remove the pot from its housing. Then, cut the wires from the circuit board leading to the pot you removed. Keep a sufficient length of wire on both the circuit board and pot to connect

new wires. Next, remove the transmitter circuit from the transmitter housing (Figure 14).

The end joint of the lamp fixture that holds the lamp socket and shade can also hold the potentiometer. Loosen the screw that controls the tension and/or position of the lamp socket on the lamp arm. If necessary, remove the screw completely. The lamp socket is held on a shaft. Gently remove the lamp socket assembly from the arm.

Once the lamp socket assembly is removed, cut the wires holding the lamp socket to the fixture. Leave 3 inches or so of wire on the fixture; we need to use them shortly.

The potentiometer (previously removed from the transmitter) fits perfectly in the end joint fixture (Figure 15). We will use the wires left on the fixture to pull the three 22 ga. stranded wires through the fixture for the pot control. You don't need to do this operation. You could just tape the wires to the outside of the fixture. But having the wires pulled through the fixture gives a professional and cleaner look to the head tracker.

Cut three lengths of 22 ga. stranded wire about 2 feet longer than the length of the lamp fixture. If the wires have different color insulation, all the better. It will help when connecting the pot to the circuit.

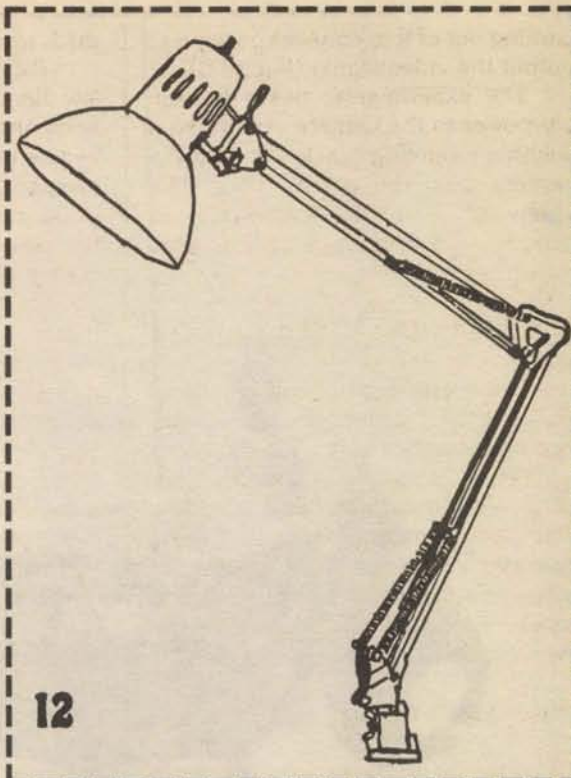
Strip off about 1/2" insulation from the fixture wires. Solder one end of the three 22 ga. wires to the fixture wires. We are soldering the fixture wires to the 22 ga. wires to make a good mechanical bond to pull the new wires through the fixture. If you just tape the wires together, you'll stand a good chance of getting the wires halfway through the fixture before it pulls apart. Once the wires have been pulled through, cut off the fixture wires.

Solder the ends of the three wires pulled through the fixture to the wires left on the pot. Solder the opposite ends of the wires to the transmitter circuit. Make sure that the wires from the pot are reconnected to their original connections on the circuit board.

Reconnect the antenna to the transmitter circuit if it had to be removed when disassembling the transmitter. Use a battery power supply similar to those used on the car. The new power supply should be of equal voltage to the original. The transmitter circuit board can be placed in any suitable enclosure that can hold the transmitter and power supply.

Connection to HMD

We use two magnets to connect



12

the potentiometer on the lamp arm to the top of the HMD. The ceramic magnets are 1" x 1" x .5" in size. Use epoxy glue or hot glue to secure the magnets to the bottom of the pot and top of the headstrap of the HMD. Make sure the magnetic fields of the magnets are aligned properly so that they attract one another after they are secured to their respective components.

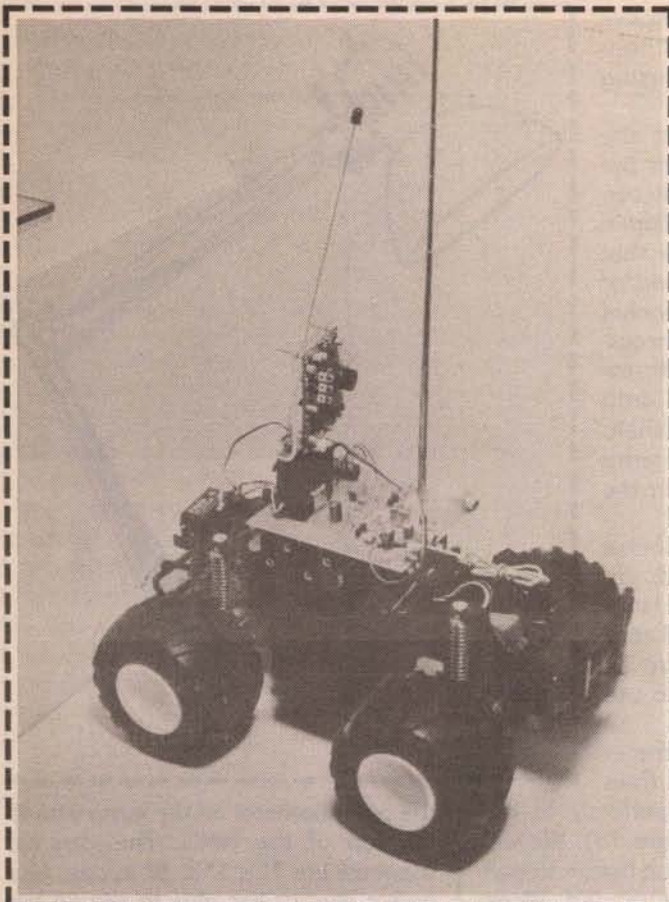
Do not substitute a piece of steel for one of the magnets. The magnet-steel connection will slip when the HMD rotates.

13



Position the lamp arm so that the potentiometer is in close position to where the HMD will be when worn by the operator. To make the connection, bring the HMD and pot magnets together. Turn on both circuits. As the HMD turns, so does the camera/servomotor. The effect is dramatic.

Theoretically, I knew what to expect from the head-tracking system — turn my head and the camera pans in that direction. However, that didn't prepare me for the real time operation of the video link. I was impressed with overall performance and I hope you are too. After the initial euphoria, adjust the system to minimize any physical stress (meaning, align the lamp arm to the perfect height and direction for coupling to the HMD).



Adding Realistic Car Controls

Golem I uses the standard RC control that came with the car. The realism of the telepresence system can be greatly improved by adding realistic car controls. This isn't difficult. What is involved is removing the circuit and potentiometers from the RC transmitter control, making a mock-up steering wheel for one potentiometer and a foot pedal throttle control for the other potentiometer.

Adding Sound

Golem I has the facilities for sound. All you need to do is add a microphone and preamp to the car. The signal output from the preamp is fed into the sound in the RCA plug on the video transmitter.

The sound will be transmitted to the TV along with the video. If you wish, you can plug headphones into the earphone jack on the LCD TV for private listening.

Talk

A child's walkie-talkie can be placed on the T-Bot allowing the operator to speak from the T-Bot.

Improving the Telepresence System

Golem I is a basic telepresence system that can be improved tremendously with a little thought. All improvements will add cost to the system. However, these sub-systems may be added over a period of time.

Stereo-Vision

Implementing stereo-vision on the Golem I is a worthwhile endeavor. There are a great many benefits to be derived, most importantly, depth perception. Before undertaking this

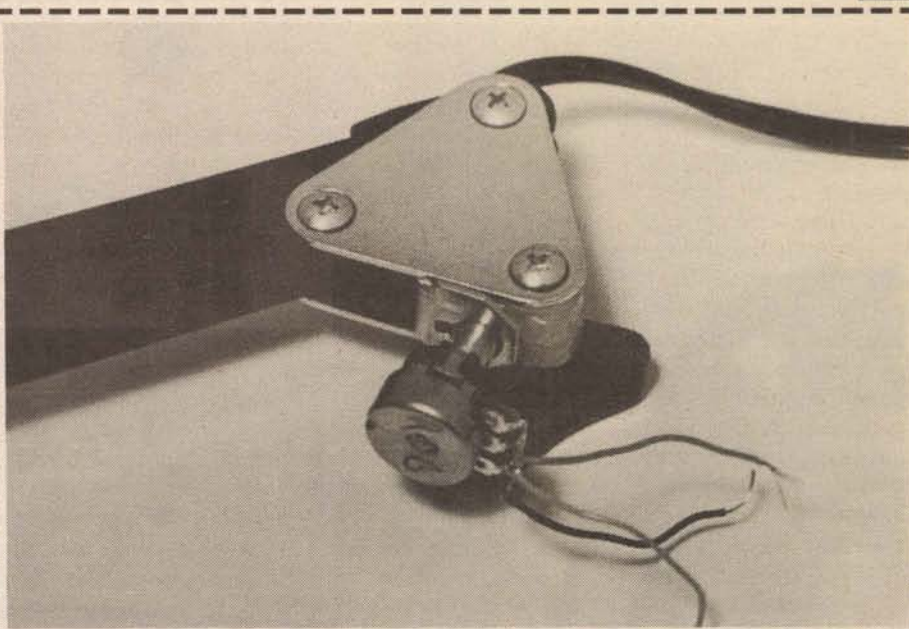
project, it is important to realize that the HMD (from a previous article) can only present monographic video images. Therefore, the HMD will also need to be rebuilt using two LCD displays to display the stereo-graphic video. The reader, of course, has the option to design a stereo-graphic system outside an HMD.

The small size of the miniature

sional picture. However, the stereo images transmitted will not contain convergence clues as discussed previously in the HMD construction. The stereo video cameras are in a fixed position looking straight ahead.

To include convergence clues would require extensive engineering. The HMD would need to incorporate eye tracking.

15



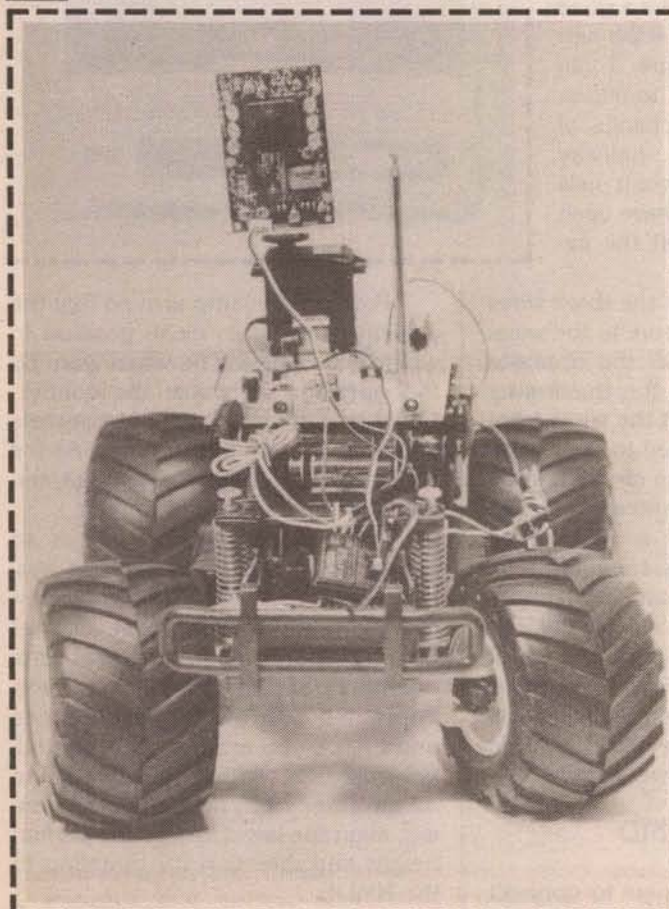
16 Troubleshooting

Assume the camera and HMD are not properly aligned (meaning when the HMD is facing straight ahead, the camera is veering to one side or the other). This is a simple problem to correct. Loosen the screw holding the potentiometer shaft in the lamp assembly. Turn the shaft until the camera and HMD are perfectly aligned, then retighten the holding screw.

If the camera zigs when it should zag, reverse the outer leads on the potentiometer.

The finished golem robot is illustrated in Figures 16 and 17.

17



video camera is perfect for stereo-graphic imaging. Two cameras can be positioned side by side at a same interocular distance (IOD) of the eyes. To be more specific, the average interocular distance for adult humans is 63 mm. The camera's lens can be positioned, from center to center, at 63 mm apart. This is the same space between the lenses that the eyes use for depth perception.

Seeing in stereo from the golem provides depth perception to the operator when they are driving. Stereo-vision becomes increasingly more important when robotic arms are in use. Being able to see the manipulator (robot arm)

move along the Z axis allows for efficient operation.

The Z dimension is lost in a monocular view. This forces operators to gently bump into objects to approximate the robotic manipulator's location along the Z axis.

In addition to the video cameras, two video transmitters — one for each camera — are required. The transmitters should be tuned to transmit on different TV channels.

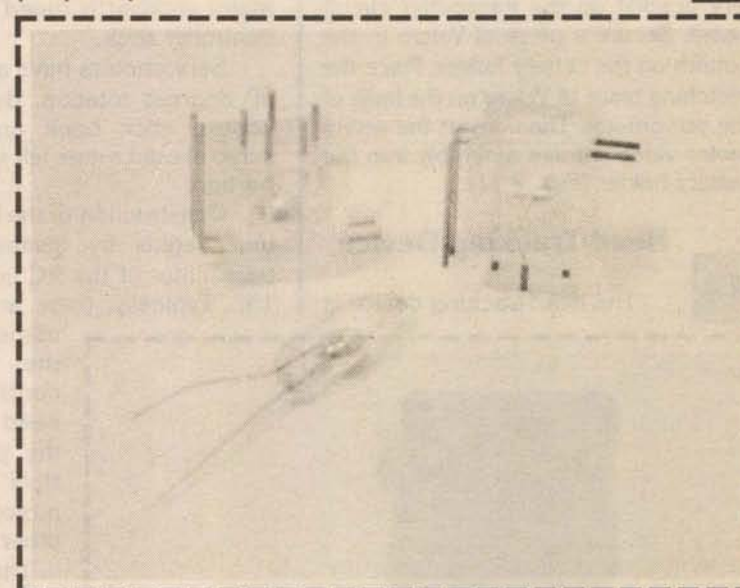
When the stereo system is set up, the operator of the vehicle will see the T-Bots environment as a three-dimen-

The eye tracking information would then be transmitted to servomotors that would rotate the video cameras in direct proportion to the eye convergence. A master-slave system such as this is currently beyond the hobbyist market.

Digital Compass

Previous VR articles have

18



included plans for a digital compass that is suitable for use on the golem. The compass can be set up in two different ways. The first method keeps the LEDs of the compass in the visual field of the video camera. A quick look informs the operator in which direction the golem is traveling. The second option uses a radio link between the digital output of the compass on the T-Bot and the remote location of the operator.

The digital compass is needed more on boat, submarine, or flying golems that will be discussed in

future articles. Golem I can be used for systems design and check-out.

Rumble Interface

When driving the model car via telepresence, you can not feel the roughness of the road as you drive. To incorporate a rumble feature into the system, you could use the spring suspension of the model car. Any number of sensors can be used for this purpose. For instance, piezoelectric transducers, hall devices, and strain gauges.

The challenge to the experimenter is not in detecting the rumble, but in providing that information to the seat of the operator. Most motion platforms use expensive pneumatic and hydraulic systems. If cost is an issue, this isn't an option.

A cheaper solution can be found in the ThunderSeat by ThunderSeat Technologies. The ThunderSeat utilizes any sound source to generate vibratory sensations. It contains a subwoofer speaker coupled to an acoustical wave chamber inside the seat. The wave chamber vibrates the entire seat. The low frequency (woofer) speaker can handle up to 100 watts of power. Frequency response of the system is 50 Hz - 3.7 KHz. This was originally designed to work with flight simulator programs running with a sound card on a PC. The output from the sound card is fed into an amplifier, then to the ThunderSeat.

Tilt Interface

Not all cats are grey, nor all roads level. As with the rumble interface there are several transducers one can use to determine tilt. Figure 18 illustrates two simple tilt sensors. One

uses a steel ball in a plastic enclosure. When tilted, the steel ball makes contact with electrodes placed in the enclosure. Mercury switches may also be used.

Electrolytic tilt sensors are expensive, but are excellent sensors. A single electrolytic sensor can provide tilt information from two axes. Spectron Inc.'s SP5000 sensor is hermetically sealed, with one center electrode surrounded by four equidistance electrodes. As the electrolytic fluid makes contact with the internal electrodes, the AC resistance between the electrodes varies in proportion to the degree of tilt.

Unfortunately, the electrolytic sensors cannot be read using a DC voltage source. This would cause the deposits to form on the electrodes rendering them useless. Instead, an AC voltage of approximately 3 volts with a frequency of 1000 Hz is fed to the sensor. The AC voltage from the center electrode is in proportion to the tilt of the sensor.

If one were to use the electrolytic tilt sensor, I can suggest one way to set up the information flow. Connect the AC output of the tilt sensor to a bridge rectifier to obtain a DC equivalent voltage. The DC voltage is fed to a voltage controlled oscillator (VCO). The VCO output frequency varies in proportion to the input voltage. The output of the VCO is transmitted over a radio link to a receiver on the motion platform. The receiver reads the frequency (tilt) and activates a proportional control to tilt the platform.

Spectron Inc. offers an integrated circuit — the SA40011 — that simplifies interfacing electrolytic tile sensors. The DC output from the SA40011 can be fed to a VCO as described above.

Again, implementing tilt to the operator is the difficult part of the system. Proportional pneumatic or hydraulic systems can be employed to the seat to provide tilt.

Greater Video Range

The video range of our small transmitter is approximately 300-2000 feet. That's about the limit for a street legal transmitter operating on TV broadcast bands. Obviously, for longer distances, another system needs to be employed — amateur television (ATV).

ATV has been around for a number of years. It's been a method for radio amateurs to communicate via two-way television. ATV had been the province of the elite radio hobbyist due to the expensive cost of equipment. However, recent advances in solid-state technology have changed that.

The components for a 5-watt ATV system can be purchased for \$200.00, excluding TV monitor and video camera. The video camera on Golem I and the LCD TV in the HMD are suitable for ATV use. Less powerful ATV systems (3/4 watt) can be purchased for under \$100.00. That is still seven times more powerful than the transmitter currently used on the Golem I.

A Technician Class amateur license is required to operate these systems legally in the U.S. Currently the Technician Class license no longer requires a knowledge of Morse code. Interested readers should contact a local amateur radio club for more information. Or you may write American Radio Relay League (ARRL), Newington, CT 06111; (203) 666-1541.

A 5-watt ATV system can trans-

mit a distance up to 30-40 miles, depending upon local radio interference, terrain, weather, etc.

More Models

With the experience gained in building this T-Bot system, the reader can build other models. The company that makes erector sets has revitalized and updated themselves and brought a number of interesting kits to the market. The kits are called Meccano-Erector sets that include motors, gears, and pulleys along with the standard erector set materials.

There are standard kits for building trucks, cars, motorcycles, land rovers, etc. The kits provide a good springboard for building exotic T-Bots explorers. Kits are available locally through Toys R Us dealerships. **NV**

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Radio Control System (1 receiver)	\$50.00
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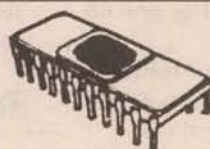
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The speed control system has advanced more than any other component of the electric vehicle (EV) in the past 20 years.

The controller is the electrical equivalent of the carburetor in a gas car. It meters out the energy from the fuel source to the motor according to the amount of speed (or power) needed.

by Shari Prange

Electric Car Controller Evolution: on the left is an early transistorized PWM controller; on the right is a modern MOSFET PWM controller and potbox.

Speed Controllers

the car's energy was wasted as heat. It was also a fire hazard.

SCR

Silicon controlled rectifier (SCR) controllers were a great leap forward. This type of controller is known as a "chopper,"

because it "chops" the electricity flowing to the motor. In essence, the controller functions as an on-off switch. At any given instant, the power is either full-on or full-off, but the pulses happen so rapidly that the

effect is an averaging of the power. In other words, the motor behaves as if it were receiving steady power at an intermediate voltage between full-on and full-off.

This average value can be moved up or down the scale by varying the frequency of the pulses or the duration of the "on" cycle relative to the "off" cycle. The SCR controller used both techniques. At higher speeds it held the frequency constant and modulated the pulse width. At lower speeds, it varied both frequency and pulse width.

The SCR controller simplified the wiring and

gave smoother performance with a greater range of speeds. However, it had its drawbacks. Its operating frequency ranged from .02 KHz to .4 KHz, which produced an ugly growling noise. It required a bypass contactor to achieve full throttle, which could result in a runaway condition if the contactor failed in a closed position. It was bulky, and left its components exposed to the elements.

Finally, it still had some efficiency losses in the form of heat, and

these were most serious right in the middle of the performance range, where most normal driving is done.

Transistors

The next advance was the transistorized pulse width modulated (PWM) controller. This was also a chopper, but it held the frequency constant at 2 KHz. This was still in the audible range, but sounded like a whistle or a hum.

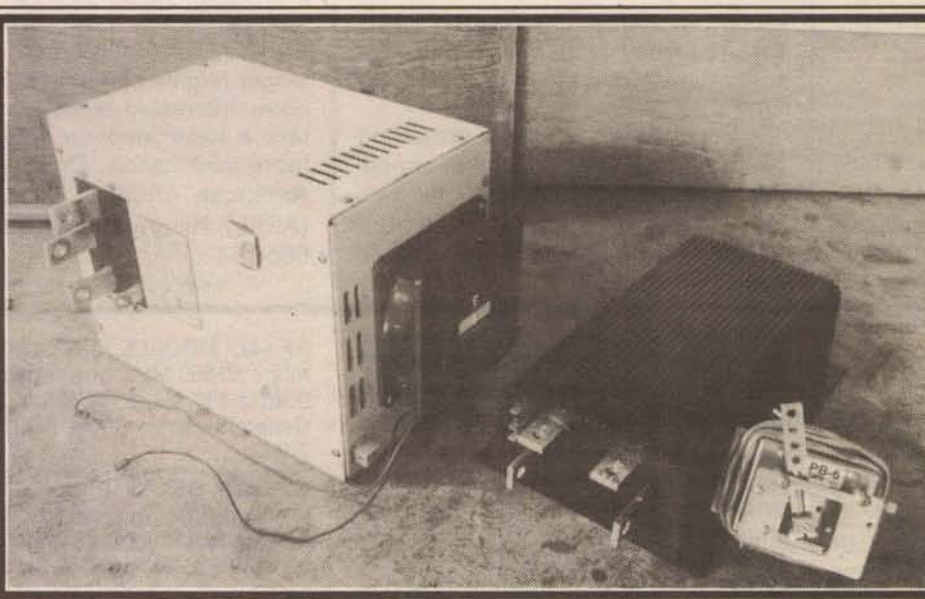
The PWM controller was smaller, lighter, quieter, smoother, more efficient, more reliable, and simpler to install. Later models came sealed in potted aluminum cases with extruded heat fins.

The PWM controller for EVs owes its existence to three men. Frank Willy developed the first transistor PWM controller for EVs in the early 1970s. One of his licensees, Ric Barline, developed a new design using Darlington transistors, and started his own company, SES (Siskiyou Energy Systems). Independently, Steve Post developed a third design

Series/Parallel Switching

When you look at the inaccuracy and unreliability of early firearms, it is amazing that they lasted long enough to mature as a technology. Likewise, it is amazing that the early crude EVs inspired enough loyalty to keep them alive until they evolved.

The early electric vehicles used a control system right out of Dr. Frankenstein's laboratory. The battery pack in those days was usually 48 volts, only half of what it is today. It was wired so that it could operate, at the flip of a switch, as either two



24-volt packs hooked together in parallel or one 48-volt pack.

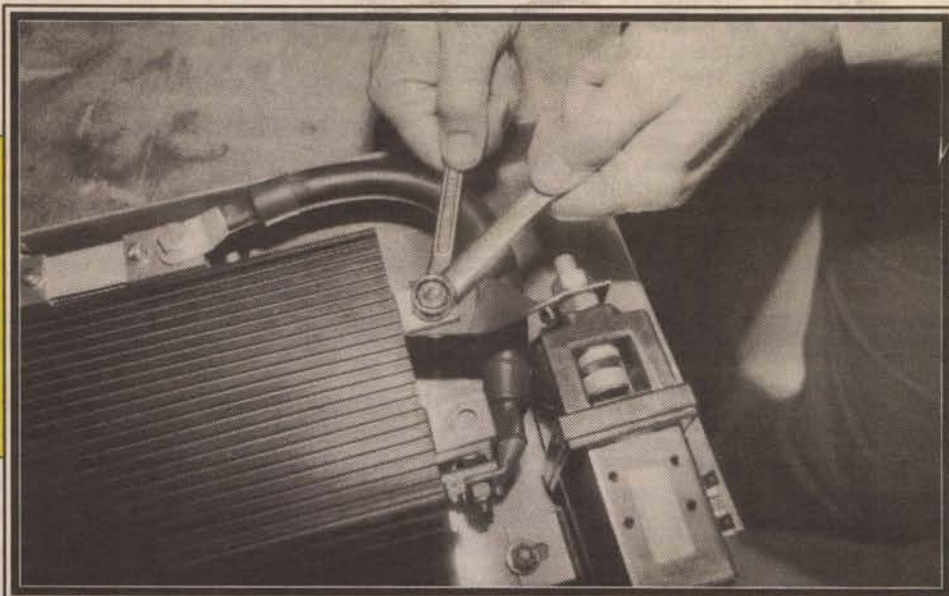
This system, combined with a manual transmission, gave a confusing range of speeds from dead crawl to merely underpowered. The transitions between speeds were jerky and unpleasant, and the car sucked up great rivers of current, giving it a very short range.

Resistance

The next speed control system was a stepped resistance system. In this arrangement, energy from the battery pack was bled off into a series of resistors. At low speed, only a small fraction of the energy reached the motor. As each resistor was progressively eliminated from the circuit, the car travelled faster.

By using enough steps, this system could be much smoother than series/parallel switching. However, it was still horribly inefficient since most of

Electric Car Conversion



amps instead of the 400 amps of the current model.

fan might be added to squeeze out a little extra performance.

Mounting

Installing the controller and main contactor on the heatsink plate on the workbench, using two wrenches to minimize stress to the terminals.

The MOSFET controller can be mounted in any position. It is important to have good access to the terminals. Trying to work on inconveniently placed terminals often causes twisting pressure to be placed on the terminal. This can crack the potting, and allow moisture to seep inside and short out the controller.

For this reason, it is recommended to use two wrenches when fastening

cables to the terminals, to avoid stressing the terminals.

Another helpful technique is to use the heatsink plate under the controller as a mounting plate for the main contactor as well. Then most of the wiring can be done comfortably on a workbench before the assembly is installed in the car.

A horizontal position is preferred if it allows access to the terminals. A terminals-down position may expose them unnecessarily to road splash. A terminals-up position may allow moisture to pool around the terminals.

In the car, it should be positioned as close as possible to the motor terminals and contactor, while taking into account serviceability of the terminals and airflow for cooling.

Potbox

The controller receives its instructions from the car's throttle pedal, through a potentiometer, or "potbox." This is a 0-5000 ohm unit with a lever arm that can be easily attached to a throttle cable.

Mounting the potbox and adjusting the throttle linkage are crucial. The potbox must be rigidly mounted so that there is no flex when the lever is pulled. It requires a return spring to insure full return when the throttle is released. The lever must be capable of reaching both full-on and full-off positions. If it cannot reach full-off, a microswitch safety feature will not allow the car to start.

Smooth Sailing

Today's EV controller is a very well-developed technology. There is no excuse for a noisy, jerky, inefficient EV with serious safety concerns. Smooth, quiet, reliable, safe performance is readily available. **NV**

and founded his company, PMC (Post Motor Controls).

In 1982, Barline closed down SES and bought into PMC with his Darlington design and extruded aluminum case. Post continued to refine the design, and PMC grew to dominate the EV controller market for road-going EVs. PMC's main markets, however, were other types of EVs ranging from wheelchairs to golf carts to industrial vehicles.

In 1984, Curtis Instruments of New York bought PMC. PMC has continued to function as a division of Curtis Instruments with a great deal of independence and continues to dominate the controller market.

MOSFETs

The next stage in the evolution of the PWM controller was the metal oxide semiconductor field effect transistor (MOSFET). This produced a more streamlined package without the heat fins, a broader range of input voltages, and a higher operating frequency (15 KHz) which made it virtually silent.

PMC was building MOSFET controllers for smaller applications for some time before they brought one out for road-going EVs. The decision point came when they lost their source for matched Darlington transistors, and hand-matching them was not cost-effective. They already had the MOSFET technology in smaller applications. However, the road-going EV market was not large enough to justify tooling up for a new product size.

Steve Post, however, was a strong believer in EVs, and wanted to find a way to make it work. He researched the market and discovered that all milk trucks in England (known as "milk floats") are electric, and they operate in the same voltage ranges as EV conversions here.

With this market to justify the expense, the road-going MOSFET PWM was introduced in 1988. This is the controller that dominates the industry today.

The previous generation of controllers had one model for 72-96 volts input, and another model for 96-120 volts input. If a car owner started with the smaller unit and later wanted to upgrade his vehicle to 120 volts, he had to buy a new controller. The MOSFET line introduced one model to cover the entire input range from 72-120 volts.

PMC is now preparing to introduce a new model MOSFET controller which will accept inputs of 96-144 volts, and has a current limit of 500

(pronounced "igg-bits"), which stands for "insulated gate bipolar transistor." The MOSFET-vs.-IGBT debate is undecided so far, although the PMC MOSFET controller still dominates the marketplace.

IGBT proponents claim higher efficiencies. Also, fewer IGBTs than MOSFETs are needed in the controller.

On the down side, the IGBT controllers in limited availability now are bulkier, noisier, and have higher cooling requirements. While fewer IGBTs are used, each one is many times costlier than a MOSFET.

Finally, IGBT benefits become most pronounced in systems of 144 volts or higher. These systems are outside the range of the EV conversion for the average person.

AC & Others

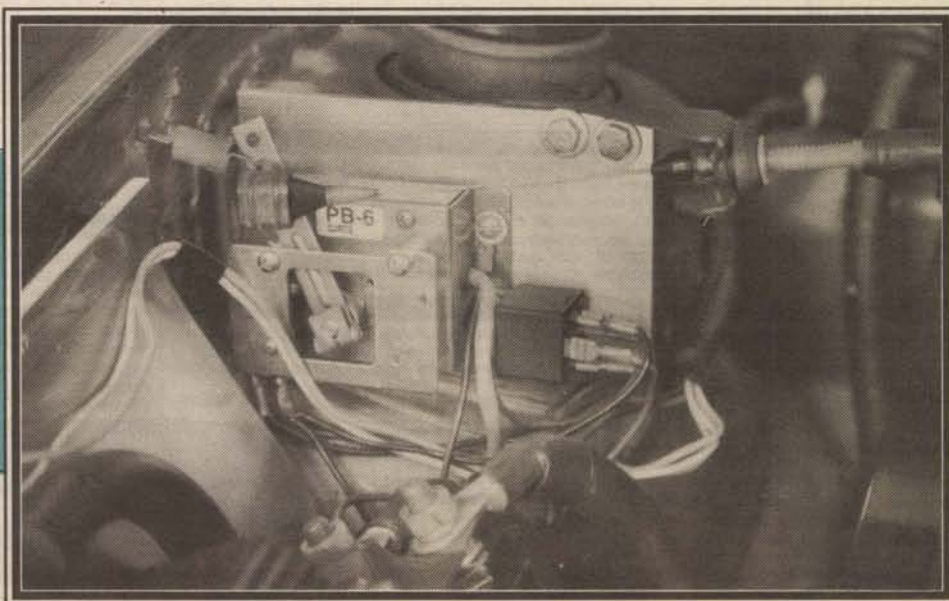
I have concentrated on control systems for series brush DC motors because that is overwhelmingly the motor of choice in conversions. AC systems, while a tad more efficient, require controllers that are four to six times more complicated, and accordingly more expensive. Controllers for brushless DC motors are similarly costly. Permanent magnet and other types of motors are nearly nonexistent for road-going EV conversions.

Cooling

The performance of a controller is affected more by temperature than any other factor. The MOSFET controller is cooled by mounting its base on an aluminum heatsink positioned in the normal airflow. This is perfectly adequate for normal

A potbox connected to the car's original throttle cable and mounted securely, with a return spring on the lever arm.

street use. For hard use such as racing, a larger, finned heatsink or even a

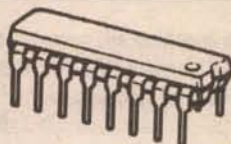


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Parts and Kits, 1935 South 3rd West No.
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**EPROMS, UV erasable. Brand new, not
pulls. 27C256 (32K x 8 bit) 150 nSec \$3
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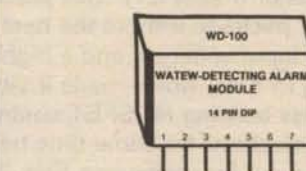
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WATER DETECTING ALARM. Just about
every basement needs at least one water
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When in alarm, the system will produce a
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MHz AM air band, smooth varactor tuning superhet with
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AR-1 kit.....\$29.95 Matching case set, CAR.....\$14.95

FM RECEIVERS & TRANSMITTER

Keep an ear on the local repeater, police, weather or just
tune around. These sensitive superhet receivers are fun to
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have smooth varactor tuning with AFC, dual conversion,
ceramic filtering, squelch and plenty of speaker volume.
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applications. 2M FM transmitter has 5W RF out, crystal
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World's smallest FM wireless
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Pick the unit that's right for you. All units transmit a stable
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FM-1 Basic unit.....\$5.95
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very sensitive audio pickup.....\$14.95
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for FM-1,2,4.....\$2.95

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Add concert hall realism to your stereo, TV or even 2-way radio! Easily synthesize a stereo effect from mono sources or richly
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Control virtually anything by Touch-Tone remote control. The URC-1 has 16 switched outputs, 4 adjustable voltage outputs
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SCA-1 Decoder kit.....\$27.95 CSCA Matching case set.....\$14.95
FR-1 FM receiver kit.....\$24.95 CFR Matching case for FR-1.....\$14.95

L-C METER

Measure inductors from 10 uH-10mH and capacitors from 2 pF-2uF with high accuracy by connecting the LC-1 to any
digital multimeter. Two pushbutton ranges for high resolution readings and we even give you calibration components to
assure proper accuracy of your kit! Active filters and switching supplies require critical values, no one should be without
an accurate LC meter. For a pro look, add our matching case set.

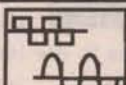
LC-1 LC meter kit.....\$34.95 CLC case set.....\$14.95

MOTOR CONTROLLER

Control the speed and direction of any motor. Use our SMD-1 for those nice steppers you
see surplus, and our MSC-1 for DC motors. The stepper driver features variable speed, half
step rotation, direction and power down mode, can drive most any stepper motor. Our DC
driver features pulse width modulation control allowing full motor torque even at
low speeds and can drive motors up to 50 VDC @ 10 Amps! Add our case set
for a professional assembly.

SMD-1 Stepper kit.....\$24.95 MSC-1 DC motor kit.....\$24.95
CSMD SMD-1 case.....\$14.95 CMSC MSC-1 case.....\$14.95

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DDS (Direct Digital Synthesis)
technology brings you a terrific audio
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Generates from 0.01 Hz to 50 KHz with
five digit LED display of frequency. Sine
and square wave output adjustable 0-5
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accuracy of 10 ppm and two memories for rapid frequency
changes. Retire that jury-rigged old generator and treat
yourself to the pleasure of using a new state-of-the-art SG-
550!

SG-550 Kit.....\$199.95 SG-550WT assembled.....\$269.95

SHORTWAVE RECEIVER

Fantastic receiver that captures the
world with just a 12" antenna! Can
receive any 2 MHz portion from 4-11
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varactor tuning. AGC, RF gain
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Fascinating Scout, school or club project, provides hours of
fun for even the most serious DXer. For the car, consider our
shortwave converter. Two switchable bands (in 3-22 MHz
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Shortwave converter kit, SC1.....\$27.95
Matching case set for SR1, CSR.....\$14.95
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High quality, true AM broadcast band transmitter is designed
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even antenna ideas. Be your own Rush Limbaugh or Rick
Dees with the AM-1! Add our case set for a true station look.
AM-1 Transmitter kit.....\$24.95
CAM Matching case set.....\$14.95

SCANNER CONVERTER

Tune in on the 800-950 MHz action using
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converted with crystal referenced stability
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are even included on building high
performance 900 MHz antennas. Well designed circuit features
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matching case set for a professional look.

SCN-1 Scanner converter kit.....\$49.95
SCN Matching case set.....\$14.95
SCN-1WT Assembled SCN-1 and case.....\$89.95

STEREO FM TRANSMITTER

Run your own Stereo FM radio station! Transmits a stable signal in
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FM-10A Stereo transmitter kit.....\$34.95
CFM Case, whip ant set.....\$14.95



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current charge while being monitored by a negative delta-V system that cuts off the fast
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NiCads or NiMH packs from 2 to 10 cells (easily expanded) and current capacities up to
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wired and tested with case at a special price. Kit builders: add our matching case set for
a snazzy finish.

DN-1 Dr. Ni-Cad conditioner/fast charger kit.....\$49.95
CDN Matching case set.....\$14.95
DN-1WT Fully assembled Dr. Ni-Cad with case.....\$89.95

SPEED RADAR

New low-cost microwave Doppler radar kit "clocks" cars, planes, boats, horses, bikes or any
large moving object. Operates at 2.6 GHz with up to 1/4 mile range. LED
digital readout displays speed in miles per hour, kilometers per hour or
feet per second! Earphone output allows for listening to actual Doppler
shift. Uses two 1-lb coffee cans for antenna (not included) and runs on 12
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case with speedy graphics for a professional look. A very useful and full-
of-fun kit.

SG-7 Complete kit.....\$99.95

STEREO PEAK HOLD BARGRAPH

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two units in one, a fast display to show the signal and a long persistence display to capture
peaks, similar units to go for hundreds of bucks! We offer 3 models: Linear for general use,
Semi-Log for audio VU meters, and Log for power displays. Dual - for stereo - 10 segment
multi-colored LED display for snazzy, eye grabbing display and easily set ranges for
virtually any signals, from voltmeters to audio VU meters to audio power amps to SWR
meters. Complete instructions for easy hook-up to most any device. Add our matching case
set for a sharp looking unit.

PH-14 Dual Linear bargraph kit.....\$39.95 PH-15 Dual Log bargraph kit.....\$39.95
PH-16 Dual Semi-Log bargraph kit.....\$39.95 CPH Matching case set.....\$14.95

SPEECH SCRAMBLER

Descramble most scramble systems heard
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controlled for crystal clear sound with a built-
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For scramble systems, each user has a unit
for full duplex operation. Communicate in
privacy with the SS-70. Add our case set for
a fine professional finish.

SS-70 Scrambler/descrambler kit.....\$39.95
CSSD matching case set.....\$14.95
SS-70WT Assembled
SS-70 and case set.....\$79.95

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Relive the radio past with a crystal set
like your grandfather built. Uses genuine
Galena crystal and catwhisker. Several
different types of radios are built,
including standard AM broadcast,
shortwave and even WW II foxhole
style. To compare modern semicon-
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comparison. No soldering required and
we even give antenna ideas. Radio for
free, get it now before Clinton taxes it!

CS-1 Crystal set kit.....\$19.95

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Grab Touch-Tone numbers right off the air, phone or tape. A simple hook-up to any radio
speaker or phone line is all that is required to instantly decipher touch-tone phone
numbers or codes. A 256 digit memory stores decoded numbers and keeps its memory
even in the event of power loss. An 8 digit LED display allows you to scroll through the
memory bank to examine numbers. To make it easy to pick out number groups or codes,
a "dash" is inserted between sets of digits that were decoded more than 2 seconds apart.
A "central-office" quality crystal controlled decoder is used allowing rapid and reliable
detection of numbers at up to 20 digits per second! For a professionally finished look,
add our matching case set. Start cracking those secret codes tomorrow with the Tone
Grabber!

TG-1 Tone Grabber kit.....\$99.95 CTG Matching case set.....\$14.95
TG-1WT Fully assembled TG-1 and case.....\$149.95

DIGITAL VOICE RECORDER

Chatterbox digital voice storage unit will record your message of up to 20 seconds.
Time is split up into four 5 second blocks which can be played separately or
cascaded for longer messages. An LED display shows message location and
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For that finishing touch, add our matching case set.

CB-1 Voice recorder kit.....\$59.95 CCB Matching case set.....\$14.95

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• NOVEMBER 18, 19, 20
• DECEMBER 9, 10, 11

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Presented in Person By:

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SATURDAY EVENING WORKSHOP. Learn how to build your own 2-meter antenna system, and learn how to install radios in a boat or car. **MARINERS** - learn all about grounding, and how to obtain XE2 Mexican privileges when cruising south. (Workshop is optional-6:00 p.m. to 9:00 p.m.)

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- The Gordon West textbook and study manual supplied free.
- Lunch and beverages included, both days.
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**Pre-registration is required. Use the form below. Pre-registered students receive 3-ring binder with Gordon West study notes, the West-written textbook, colorful frequency charts and maps, plus \$50 in equipment discount coupons. This \$75 study package included free as part of your \$195 course fee. Pre-study assignments check your progress before class.*



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Name _____ Phone (DAY) _____ (EVE) _____
Address _____ City _____ Zip _____

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Type 8598 as used in the PAS-5 IR goggles. High quality tube with unique HV multiplier encapsulated to side. Requires only 600 to 800VAC from PAS-5 power supply. (shown right). Perfect for building a covert mini viewer. **TUBE ONLY\$99**
TUBE w/P.S.....\$199



PAS-5 POWER SUPPLY

Replacement AC Oscillator for PAS-5 goggles. fits into standard supply location. Uses 3V Lithium Battery. (supplied) and custom push button switch included.....\$120



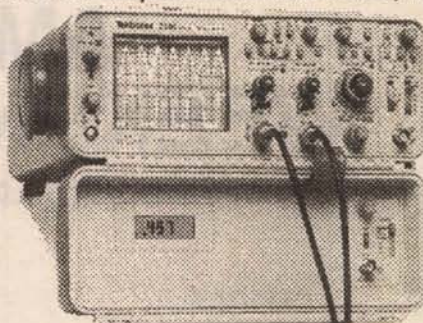
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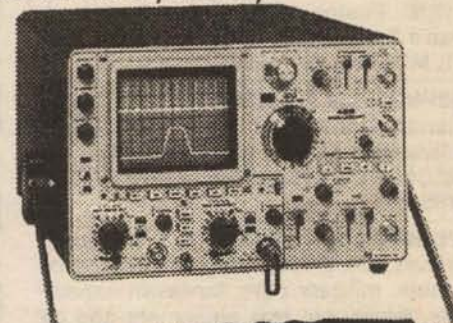
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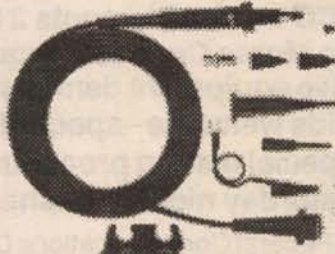
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The most powerful magnets you have ever experienced! You have seen "extremely powerful" Rare Earth Magnets elsewhere for \$15ea. "They are kids stuff," compared to these. Our magnets give new meaning to "small but powerful." Each module consists of two magnets bonded to a steel base. Size 2.5"Lx1.1"Wx.67"H. The actual magnets are only .82Lx.78Wx.32H. These little monsters can pull 50lbs! ARRH, ARRH. Yes fifty! Two of them are almost impossible to separate. NOT FOR CHILDREN. CAN CAUSE PERSONAL INJURY. USE WITH EXTREME CARE.

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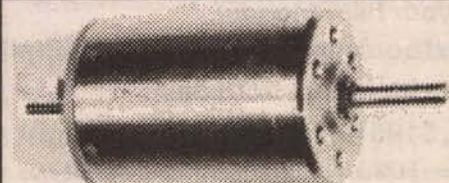


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Swiss Precision DC Motor, made by Escap. Beautiful ball bearing construction with polished case and dual shafts. 12VDC @ 7mA yields 5000RPM operation! Very quiet, very costly. Ltd. Qty.....2 for 24.95



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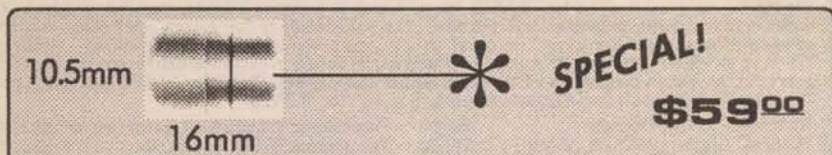
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5mW, VISIBLE LASER MODULE



SPECIFICATIONS:

Wavelength.....670nm
DC Power.....3Vdc, @65mA
Power out.....5mw max.
Range typ.....100 Meters
Class.....III A
Diode Type.....Index
Glass Collimator (fixed @ infinity)
Housing.....Machined Brass

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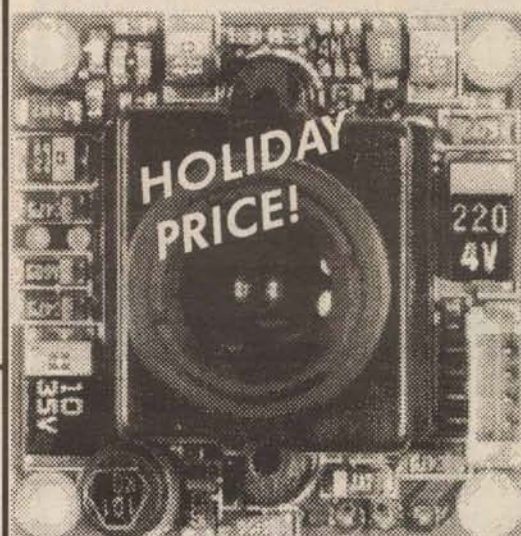


(rear view)
Switch

SPECIFICATIONS:

Wavelength.....650nm
DC Power.....3Vdc, @50mA
Power out.....5mw max. Glass Collimator
CR123A Lithium battery) Diode Type.....Index
Range typ.....300 Meters Beam Diam...1.5mm

PICTURE THIS *



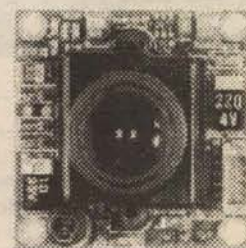
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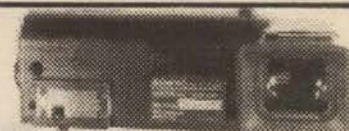
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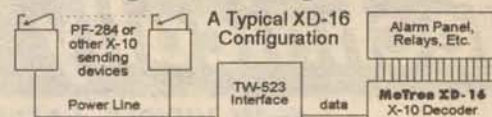
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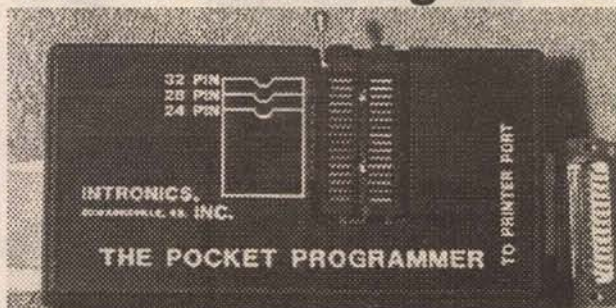
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1000uF - 50V	.61	330uF - 63V	.34
.22uF - 50V	.11	4.7uF - 50V	.13
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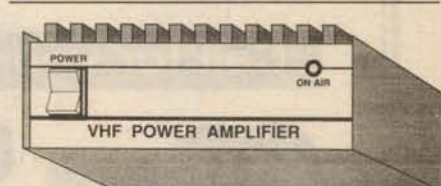
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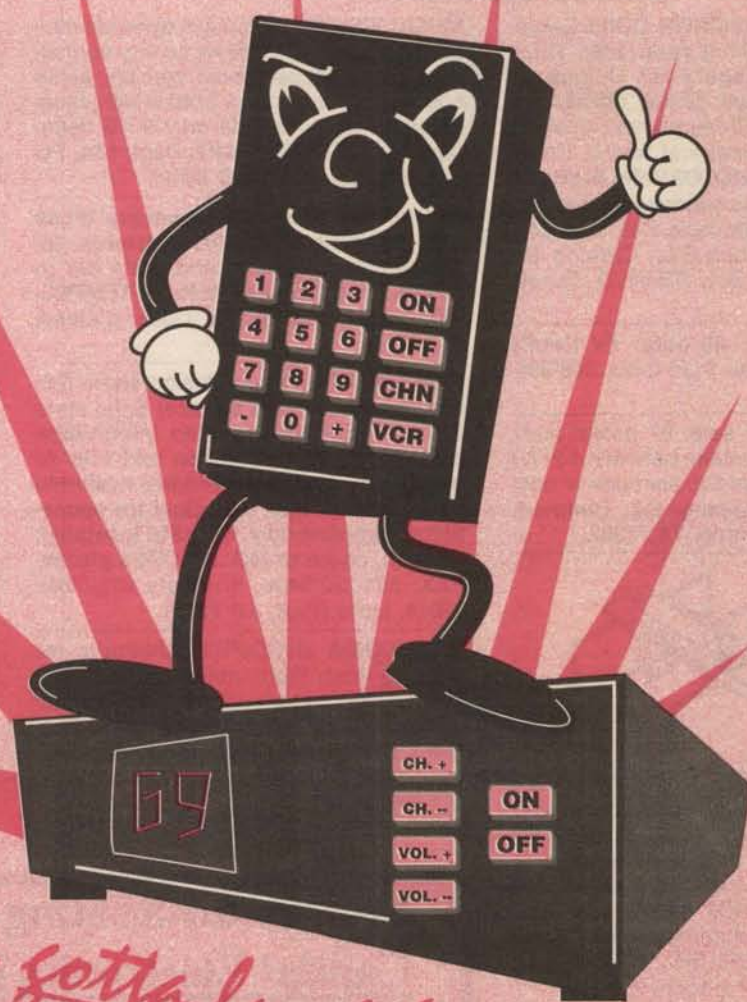
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HIGH voltage is not always easy to produce. Often bulky transformers and expensive capacitors are associated with such apparatus. The average experimenter doesn't usually require that large a power level or want to pay a lot of money for hobbyist-type projects.

In this article, we'll show you how to assemble an inexpensive (basic cost: \$20.00) apparatus, nicknamed the MHVM-10, for (M)ultipurpose (H)igh

point.

Various gases can be illuminated by the HV, even through a sealed glass container. This effect is caused by capacitive coupling. All you need is a small electrode made from aluminum foil, and the signal will be coupled to the rarefied gases within.

Circuit Description

Refer to Figure 1 for the electrical schematic. The oscillator that drives the

1:57.4 ratio, that means 11.8×57.4 or 677 volts at the secondary with no load. But wait — how do we get 10,000 volts?

First of all, note the rectifiers that convert the pulsating AC into DC. Since the peak voltage available from a DC circuit is 1.41 times the AC value, our 677 volts AC becomes 954 volts DC at the first stage. And there are 10 stages in the voltage multiplier, thus giving us a rough value of 9,500 volts with no load.

But this circuit employs a little trick to get even more voltage out — VR1.

The effect is like "stacking" 1,000 volts at each stage until you get 10,000 volts at the 10th stage. After the capacitors are charged up (and assuming no load), the circuit remains in equilibrium, and the only power drawn from T1 is used to replenish leakage losses in the components and stray losses, such as point discharge, into the air. Once a load is applied, the circuit begins to discharge the capacitors according to how heavy the load is, and they repeat the charging process each cycle, as long as there is a

Build a Safe, Multipurpose, High-Voltage Power Source

by Anthony Charlton

(V)oltage (M)ultiplier; the "-10" suffix representing the maximum kilovolts produced under normal circumstances.

Actually, the project is a simple voltage multiplier which steps up the voltage produced from a small, efficient ferrite transformer.

The completed device will produce up to 7,000 volts from a 9-volt alkaline battery, or 10,000 volts from a 12-volt source!

inverting transformer, T1, is a simple CMOS Schmitt Trigger type consisting of Gate A of IC1 plus VR1, R1, and C1. The passive components determine the frequency of the oscillator, which is normally adjusted by VR1 to 15 KHz (the frequency at which maximum power is available from T1's output).

Five additional Schmitt Trigger gates are wired in parallel to boost the current output of the project to a level sufficient

VR1 can be adjusted to hit a "resonance point" of T1. This is a point where T1 acts both as a transformer AND an inductor. Since the inductance of T1 is relatively small compared to iron-core inductors (which you tube-powered radio buffs are familiar with) we don't get that big kick that you would get with an iron-core inductor. But we do get a noticeable difference of voltage boost when VR1 is precisely adjusted, and it is just at that

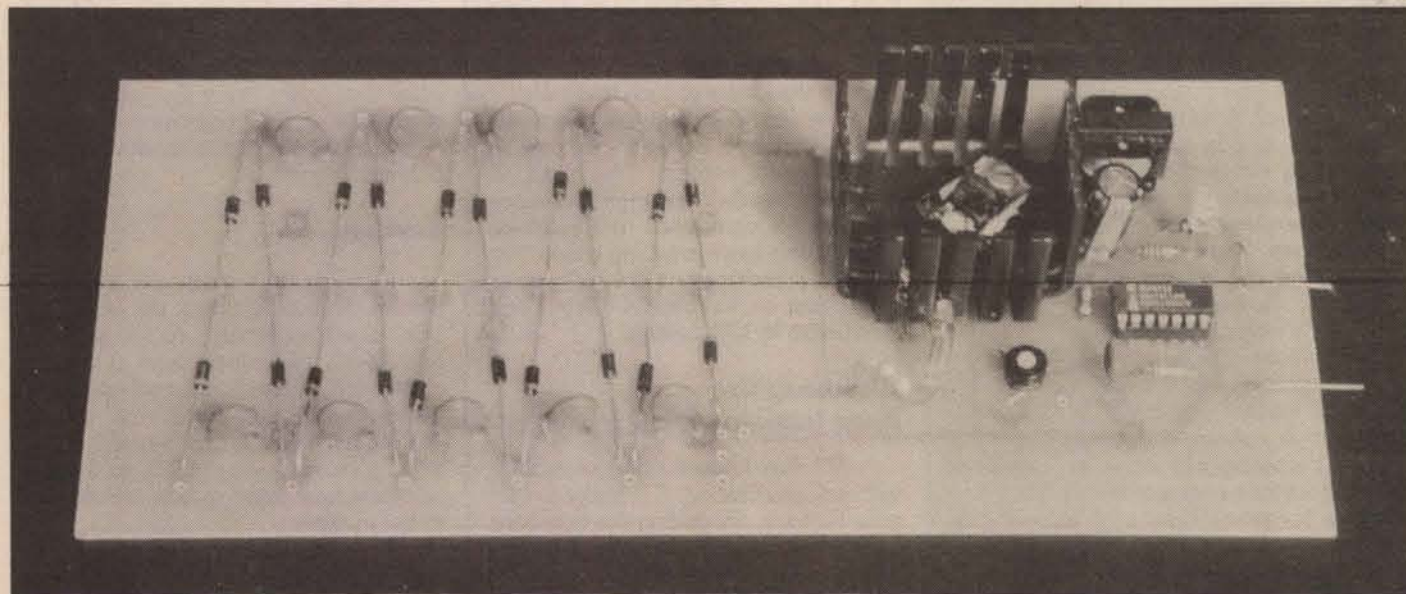
load. In reality, a small ripple is present at each step of the ladder due to the small size of the capacitors, relative to the stray losses they must replenish.

The rest of the circuit is straightforward. Capacitor C2 provides smoothing of the power source, and serves as a reservoir of current for Q1 to draw from as it switches the primary. I1, an ultra-bright red LED, shows primary power integrity. I2, a NE2 neon lamp, shows the presence of AC voltage coming off T1 and entering the multiplier ladder. Rectifier D11 provides reverse-polarity protection of the power source. A switch controls the power, and a 2-A fuse is used to protect against shorts.

Static Protection a Must

Special precautions **MUST** be used to prevent static build-up with this apparatus. First off (and I can't say this loud enough): **PLEASE KEEP THIS DEVICE AWAY FROM DELICATE ELECTRONIC APPARATUS!** This includes computers, VCRs, TVs, CD players, and so forth. Since the circuit produces positive ions, it can charge the air in a dry room while operating, and a static charge can build up on appliances several feet away. So, keep this fact in mind.

The project should be operated with an earth ground attached to battery ground. This is to prevent the project itself from becoming charged up with static as it operates, inviting destruction of IC1. This occurs easily if there is no load; a condition one encounters when doing certain experiments. The reason it becomes charged is that for every charged particle it emits or attracts (depending upon whether it is configured for positive or negative output — see the "Optimizing" box), there must be a balancing particle to equalize the charge. Thus, if it is wired for positive voltage production (actually, this is an absence of electrons at the output terminal, which has the effect of attracting electrons from any source), this is balanced by having an



We'll also explain how to adjust the voltage and current to where you like it — from about 500 volts DC all the way up to 10,000 volts DC — just by choosing the proper graduated voltage tap on the project and adjusting its current control.

What are the practical uses for high voltage? One of the favorites I've heard about is providing the bias for electrostatic speakers which need the high voltage to operate.

Another application is charging capacitors for various projects that involve energy discharge, such as powerful xenon flashlamps.

Still another use is to scientifically demonstrate various effects of high voltage, such as the "Corona Wind" given off by an energized object at a sharp

point where it is possible to exceed 10,000 volts (unloaded) at the final tap of the multiplier.

to drive transistor Q1, a TIP-31C NPN power transistor. That transistor, in turn, switches the primary of T1 with a square-wave, which emulates AC. This induces a voltage increase in T1's secondary as the AC wave alternately energizes and de-energizes the primary winding. Thus, power is transferred from the battery side of the circuit to T1's secondary, and it is stepped up by the ratio of turns of the transformer, which is 1:57.4.

Can we calculate how much voltage will be available at T1's secondary? Yes. Consider our nominal 12-volt battery input is actually about 12.8 volts with a fully charged, lead-acid battery. And, you will get about a one-volt drop between Q1's collector and emitter due to the P-N semiconductor junction. Now we have 11.8 volts switching the primary. With a

point where it is possible to exceed 10,000 volts (unloaded) at the final tap of the multiplier.

Cockcroft-Walton Voltage Multiplier

The multiplier itself is a very simple design, called a "ladder multiplier" or "Cockcroft-Walton Multiplier." Each stage increases the voltage by a factor of 100%. So, Stage 1 rectifies T1's output, and thus produces 1,000 volts. Remember, that voltage is pulsed. As each pulse comes through, the next capacitor is charged, and so on all the way up to the final stage of the ladder. After the 10th pulse, all the capacitors are charged and maintain a DC voltage within them.

excess of electrons throughout the surface of the project. So, by attaching the earth ground, these are bled away.

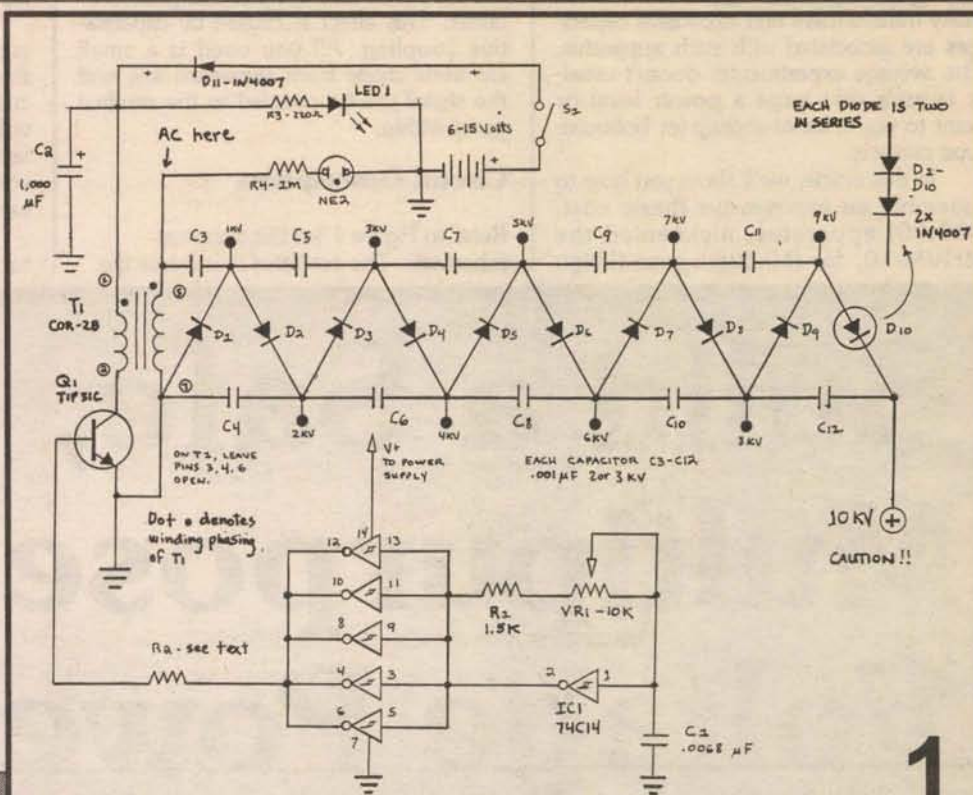
Even so, a very special socket is used for IC1. Manufactured by On-Shore Technology, Inc. (and others), it has an intrinsic 0.1 uF bypass capacitor right across the power supply terminals. So, the path for static is essentially cut off before it reaches the static-sensitive CMOS IC. I found the extra half a buck for this socket greatly reduced the incidence of destruction of IC1. If you decide to build this circuit sans purchasing the kit, these sockets are available from Allegro Electronic Systems and Digi-Key Corporation (800-DIGI-KEY; see "Parts List"). The stock number is #ED2124.

Construction

The Power Source can be assembled from our PCB pattern (Figure 2) or on bare perf-board, too. The PCB pattern has been especially engineered to allow lots of latitude when using this project. The wide spacing of the high-voltage components helps to minimize the

Also, avoid breadboarding this circuit. Difficulties have been reported with the multiplier burning out the power supply in self-powered breadboards. No fun. Plastic used for containing the breadboard hole's conductive strips is not a formulation designed to withstand high voltages. It likely will break down and create a charred arc between adjacent conductors underneath the breadboard (where the damage is invisible), leading to the circuit working not at all or poorly. At least this has been my experience.

Follow the schematic in Figure 1 and the Parts Placement Guide in Figure 3 when installing the components. Make sure your PC board or perf-board is clean. Install the components as shown, obeying polarity of the polarized components. Omit IC1 and R2 for the time being. You will certainly want to socket IC1, as explained earlier. Connect T1's secondary as shown with Pin 5 to the "hot" side of the multiplier, and Pin 7 to ground. Leave Pins 3, 4, and 6



Practice Safety with High Voltage!

Anything over 500 volts AC or DC is considered high voltage. However, we are all familiar with the fact that household voltage, at only 120 VAC, can electrocute. The hazard of high voltage is different, in that it more expediently conducts through your body — the higher the voltage, the less trouble it will have finding an easier path through your body to ground or another conductor. There is truth in the statement that voltage shocks but current kills.

While this project is not considered dangerous as is, under certain extraordinary circumstances it might be. Therefore, use these guidelines and exercise common sense while working with this or any high-voltage source.

- Avoid being shocked by the project. While the shock in itself is not dangerous, the "knee jerk" reaction it may cause can result in injury.

- People having a medical condition that could be exacerbated by electrical shock are advised not to build the project or else use extreme caution during construction.

- Always disconnect the power source when working on a high-voltage circuit, unless you must test it. If testing a working circuit, use caution. One very good habit to develop is to keep one hand in your pocket. Use properly insulated high-voltage leads and a high-voltage probe if you must test the circuit "under fire."

- Work in a dry location. Damp basements and workshops are shock-risky laboratories for high-

voltage experimentation.

- Label the apparatus at several locations with "Caution, High Voltage." Keep kids, pets, and curiosity seekers away from the apparatus. Insulate possible points of contact with high-voltage putty, or encase the device in an insulated enclosure.

- Wear rubber-soled shoes and stand on a rubber mat if you are working on a concrete floor. Surprisingly, concrete can be an excellent conductor at high voltages, depending upon how much moisture it has absorbed or if it's painted or not.

- Don't allow your body to become a conductor. That means avoiding contact with the apparatus and positioning it away from grounded objects such as metal doorframes, radiators, pipes, etc. Such objects will allow the current to pass through YOU to the ground!

- "Power Valid" lamps should be used. Note the two included on the prototype. A NE-2 neon lamp with a series resistor is great for showing that high voltage is present.

- Moving air must be provided for circuits or experiments that produce large amounts of ozone gas. Ozone gas is produced by this and all HV circuits. It has that "electrical" smell, such as that produced by older color TV sets and thunderstorms. More insulation may be required if you are getting substantial ozone. Don't "hang" over the generator while experimenting. If you become chilly, nauseated, nervous, or get a headache, it may be ozone. Get some fresh air, and the feeling will pass in a few minutes.

destruction of components due to high-voltage mishaps.

DO NOT assemble this project on Radio Shack Experimenter Grid Board or Vector Board or any other type of board with pre-etched copper donut grid patterns. These boards leak corona discharge from their foil pads like crazy, which can track to components and destroy them.

open. Figure 3 shows the pinout of T1, and if you use the PCB, it's impossible to insert T1 incorrectly.

When you install Q1, there is a little trick to getting it to fit the heatsink correctly. Since this is actually a TO-3 (monster transistor) heatsink, the smaller TO-220 package of the TIP-31C won't fit as is. This is solved by clipping off the center lead of Q1, and bending the base and

emitter leads with a pair of needle-nosed pliers.

The easiest way to make the leads fit is to bend the thick part of the two leads away from the transistor, splaying out to an angle of 45 degrees. Then, bend the thin part directly down at a 90-degree angle. Note with this heatsink the two transistor holes are not equidistant to the two mounting holes. Choose the longer mounting path, and the transistor should be able to be mounted with the leads going through the center of each lead hole.

Use plenty of heatsink grease on the back of the transistor to insure good thermal contact. The heatsink now becomes the "collector" transistor lead, and is connected to T1. Make sure it won't touch anything conductive in your prototype, or Q1 will either short out or become a target for destruction by high voltage.

Choosing the Base Resistor for Q1

IC1 has limited drive capability without overheating. To strike a balance between not driving the transistor enough for efficient switching, and driving it too much and overheating IC1, we chose a value of base resistor that is compatible with the power supply voltage.

The multiplier will operate from 6 to 15 volts. From 6 to 9 volts input, R2 should be 220 ohms. For 9 to 12 volts input, R2 should be 390 ohms. From 12 to 15 volts input, R2 should be 470 ohms.

Install the correct resistor for your application. You could also use a 300-ohm potentiometer in series with a fixed 180-ohm resistor, and adjust the potentiometer for whatever voltage you are using at the moment. Just so long as IC1 doesn't overheat, you're okay.

Finishing the PC Board

Round all soldered connections using fine sandpaper, a Dremel tool, and

wire wheel or a similar tool. Remove ALL traces of contamination using a toothbrush and isopropyl alcohol. Use of anhydrous 99% isopropyl alcohol — available at a drugstore — will speed the job.

Spray the completed assembly with two or more coats of Acrylic Conformal Coating, Silicone Conformal Coating, NO-ARC, or similar product to reduce corona discharge. Liquid Tape and RTV Silicone also work very well. Always locate the high-voltage part of the multiplier well away from the other parts, regardless of your construction method — especially the static-sensitive 74C14 Schmitt Trigger.

Testing

Connect up your power supply or battery. The voltage must not exceed 15 VDC input maximum. As we said, the MHVM-10 will operate from 6 volts up — but don't expect too much output at the lower input voltages.

Adjust VR1 to the desired power level. You may watch NE1 to observe relatively how much power is being fed to the multiplier.

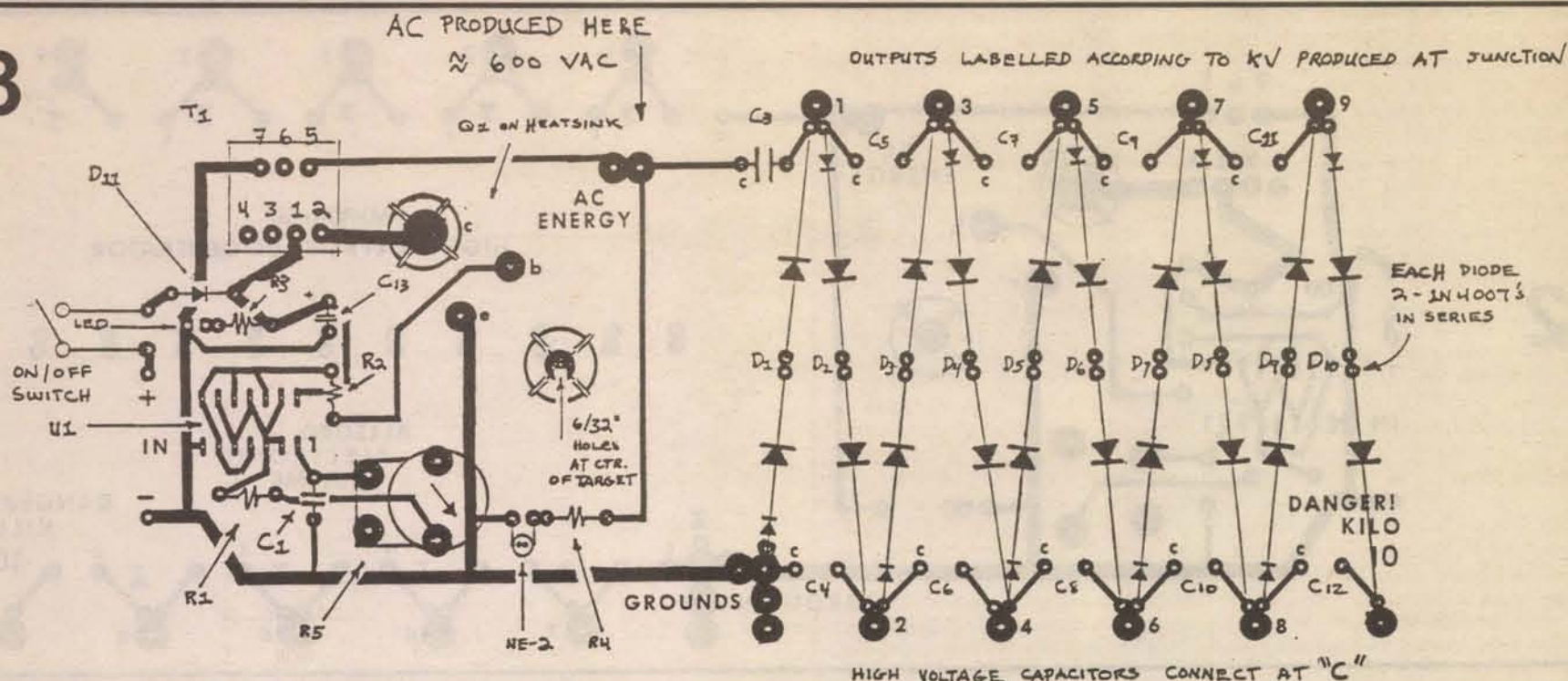
Note that when adjusting VR1 for high frequencies, battery consumption will rise. This is a result of the HF bucking the transformer's magnetic core, and is called HYSTERESIS LOSS.

Lower the frequency to about 15 KHz for maximum battery life. Greatest efficiency and maximum power output will not occur simultaneously with this kind of transformer driver circuit.

You may tap the multiplier at any point shown for various voltages and currents. The highest currents are available at the beginning of the stack, and the lowest at the end. The amperage values are in ratio, e.g., at the 5th stage up the multiplier, you get twice the current than at the 10th — but of course, only half the voltage.

About 5 watts is available at the beginning of the multiplier stack. This translates into 5 mA DC. At the end of the stack, about 0.5 mA is available. And

3



nature could greatly shorten the travel time required between earth and the celestial bodies.

Charging Capacitors — Capacitors may be charged using any of the taps on the multiplier. One wants to be careful here, because there is a shock danger when accumulating heavy charges in a capacitor. The formula for energy storage, which is measured in either Joules or Watt/Seconds (same physical unit) is:

$$J = 1/2CV^2$$

where J is the energy, C is the capacitance in microfarads, and V is the voltage in kilovolts to which the capacitor is charged. Thus, a capacitor of a given size will store 100 times as much energy at 10 kV than at 1 kV, and 10,000 times as much at 100 kV than at 1 kV. Experimenters must take this into account when charging capacitors to a

high voltage (see box on high-voltage safety).

Material Testing — The low amperage, high-voltage source is ideal for testing the integrity of materials subject to stress from high voltage. Dielectrics can be tested for resistance and puncture voltage, distilled water checked for conductivity, and circuits checked for immunity to static electricity charges, among many other uses.

Gaseous Discharge Display — Very small plasma globes can be run from the generator. But admittedly, this project doesn't have enough power to create a dramatic display. You can create a miniature firestorm inside an ordinary xenon flashlamp. The high-voltage bolt jumps and arcs between the electrodes, and it's really quite an interesting display at night. Flashtubes are available from various electronic companies such as All Electronics (see Advertiser's Index).

Laser Power Supply — Small laser tubes have been reported to operate with this circuit. We're not recommending this as a laser power supply since a properly designed laser supply is a precision circuit. But I have heard of "Micro" style tubes operating successfully at the fifth or sixth tap. Try using a ballast resistor (available from Digi-Key as a three-watt wirewound resistor) in series with the tube's anode. 50K to 100K will be required.

The multiplier is capable of supplying the high voltage to start the laser, and the 2.7 to 3.2 mA to run the tube. Make sure that T1 doesn't overheat with this set-up. Heftier transformers are available from Allegro Electronic Systems (see Parts List).

Conclusion

We hope you have enjoyed this article, and will experience many hours of pleasure exploring and using high voltage. This article is a little different from many, in that it includes some actual "case history" troubleshooting experiences. We feel writing about the actual events builders have is more productive than construction directions only. Perhaps it takes extra time to read — but it will likely save some people from hours of annoying trouble-shooting. If you agree with this philosophy, the author would be delighted to hear from you at P.O. Box 74, Cornwall Bridge, CT 06754. Address any questions by this route also. Your FAX number, which will be kept confidential, will greatly speed replies. NV

PARTS LIST

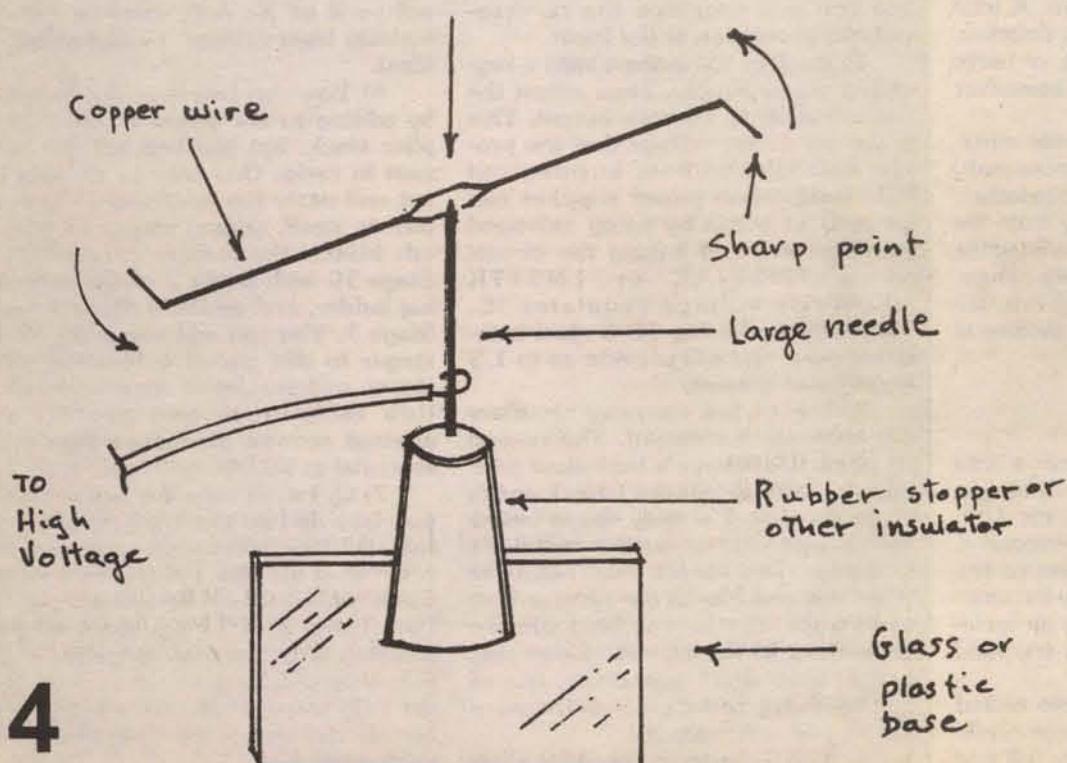
- T1 — 12V to 1,000V step-up transformer, Allegro #COR-2B or equivalent
- IC1 — Hex Schmitt Trigger integrated circuit, Allegro #74C14 or equivalent
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- D11 — 1N4007 1-A, 1,000 PIV rectifier
- I1 — Ultrabright red LED
- I2 — NE2 neon indicator lamp
- C1 — .0068 uF, polyester or Mylar capacitor
- C2 — 1,000 uF, 16 WVDC aluminum electrolytic capacitor
- C3-C12 — .001 uF, 2 or 3 KVDC ceramic capacitor
- R1 — 1,500 ohm, 5% carbon film resistor
- R2 — See text — will be 220, 390, or 470 ohm depending upon supply voltage
- R3 — 220 ohm, 5% carbon film resistor
- R4 — 1 megohm, 5% carbon film resistor
- VR1 — 10K potentiometer
- F1 — 2A fast-blow fuse
- S1 — SPST switch
- 1 — Special 14-pin integrated circuit socket w/integral bypass capacitor, Allegro #ED2124 or similar
- 1 — TO-3 heatsink and #6-32 mounting hardware

NOTE: The following parts are available from Allegro Electronic Systems, Drawer NV-4, 3 Mine Mountain Road, Cornwall Bridge, CT 06754: #MHVM-10 complete kit of parts less PC board \$19.95; #COR-2B ferrite core step-up transformer \$3.99; #MHVM-10-PCB custom epoxy-glass printed circuit board \$19.95 (please allow up to 30 days delivery time for this item); #ED2124 special 14-pin IC socket w/integral bypass capacitor \$1.00; #74C14 Hex Schmitt Trigger Integrated Circuit \$1.00. This company processes mail-in orders but does not process credit card orders. They maintain a FaxBackPronto! information service; FAX: (203) 672-4391 during normal business hours. All orders please add \$3.50 shipping and handling; CT residents add appropriate sales tax. Catalog \$1.00.

The standard parts are available from Digi-Key Corporation, 701 Brooks Avenue South, P.O. Box 677, Thief River Falls, MN 56701-0677; ph: (800) 344-4539, FAX: (218) 681-3380. Free catalog.

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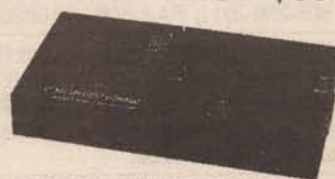
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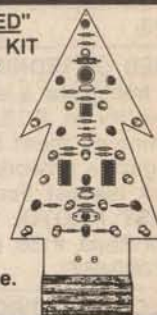
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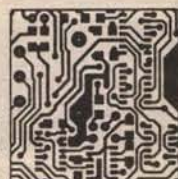
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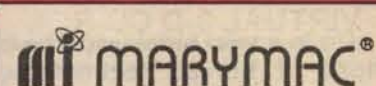
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What does a popular TV show about FBI agents investigating extraterrestrial contacts have to do with a nifty new memory component? Let's examine the evidence:

(1) An electronics company springs into existence on the western edge of the United States — a known focal point of alien operations — and adopts the name Xicor. Aliens cultures are known to favor names with lots of Xs, Qs, Zs, and Js.

Description

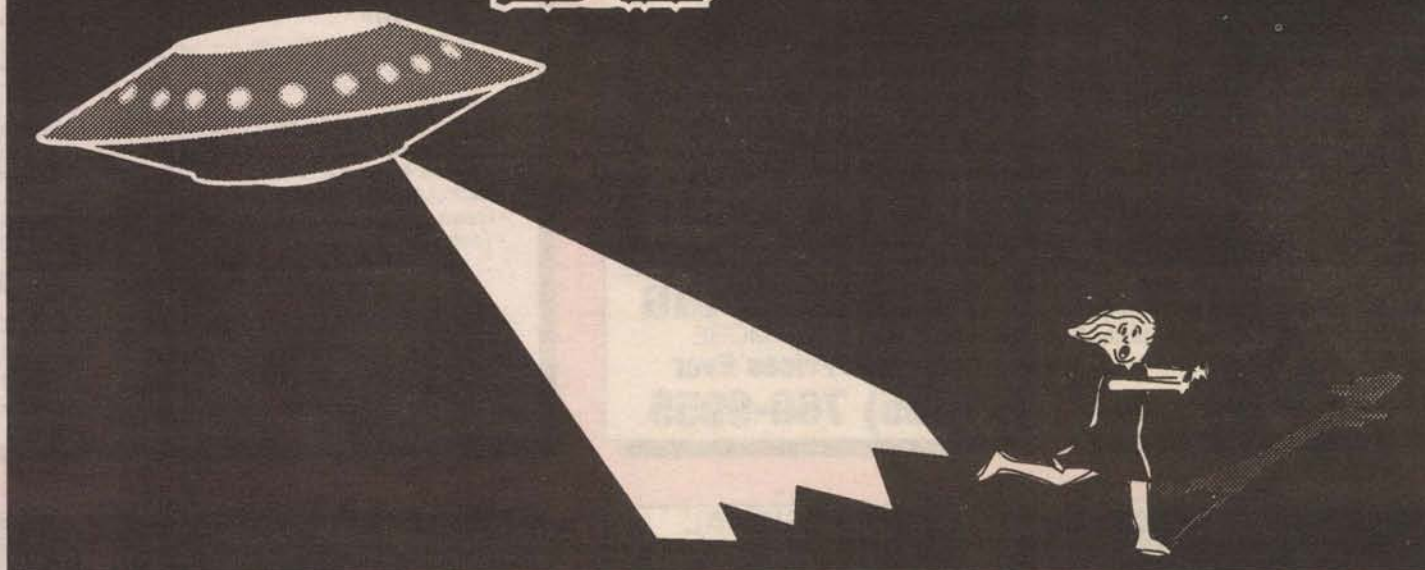
The X25640 is an EEPROM device with 8192 bytes (8kB) of storage. Like all EEPROMs, it retains data with power off. The X25640 has a high-speed serial interface, using as few as three lines to talk to a host processor. This lets Xicor house the

plex I²C. Xicor broke this rule with the X25640 by endowing

Hardware Interface

The X25640's interface is compatible with Motorola's serial peripheral

THE X FILES



(2) Xicor pioneers unusual applications of electrically erasable, programmable, read-only memory (EEPROM) technology. EEPROMs can retain data for up to 100 years without power, but can be modified at any time. Ideal qualities for the navigation system of an interstellar craft.

(3) In a total break with the traditions of human technological development, Xicor adopts a simple interface for its new 8-kB EEPROM, making it readily accessible to BASIC Stamp and PIC series microcontrollers for applications like look-up tables and data logging. Logging data on Earth's defenses, perhaps?

It's pretty much an open-and-shut case: Xicor's new X25640 EEPROM is the product of an alien intelligence.

The sooner we learn how to control it, the safer the planet will be.

Xicor EEPROM Files Away 8192 Bytes of Data in a Tiny, Solid-State "Disk Drive" for the BASIC Stamp and PIC Microcontrollers

by Scott Edwards

chip in a tiny eight-pin package — the same size as a 555 timer. By contrast, a parallel-interface device with the same amount of storage (e.g., a 2864) has 28 pins!

This miniaturization comes at a cost, however. It takes more time and more programming to communicate with a serial-interface device like the X25640 than a parallel one like the 2864. Furthermore, there are several serial-interface standards, some of which can be fairly complex to implement, such as the Inter-Integrated Circuit (I²C) standard. Others, like Microwire and SPI (described later) are simpler.

EEPROM manufacturers have followed the rule of thumb that low-capacity EEPROMs (up to 512 bytes) use the simple serial protocols, while high-capacity EEPROMs (1kB and up) use the more-com-

plex I²C. Xicor broke this rule with the X25640 by endowing

it with both high capacity and an easy SPI interface. The X25640 is intended for applications in which data is read often and written infrequently, since write operations gradually wear it out. Xicor says that the X25640 will survive a minimum of 100,000 writes. Data stored in the EEPROM should remain intact without power for 100 years or more.

EEPROMs are typically used to store calibration tables, control settings, programs, maintenance logs, and small databases (such as lists of telephone numbers in an autodialer) that change fairly infrequently, but must be retained when the power is turned off. The X25640's relatively large storage capacity, simple interface, and low power consumption (100µA inactive) make it well-suited for data logging.

eral interface (SPI) bus. The basic connections are chip select (CS), which activates the device; serial clock (SCK), which shifts data into or out of it; and data, which consists of the serial in (SI) and serial out (SO) lines tied together.

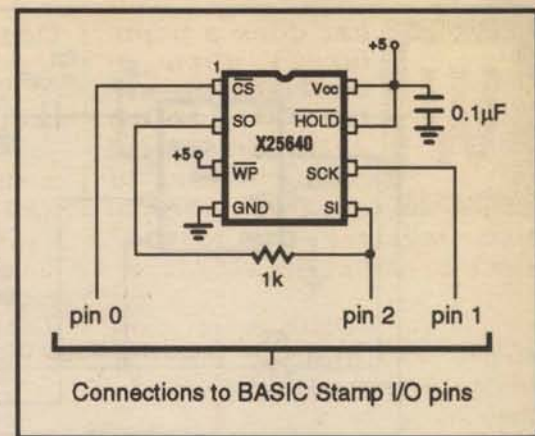
There are two other control lines — hold (HOLD) and write-protect (WP) — which are not used in these example applications. HOLD allows a busy, interrupt-equipped processor to pause a transaction with the X25640 while it tends to other business on the SPI bus. WP locks out any attempts to write to the device. Both of these lines are active low, so they are tied to VCC to disable them.

One very important point about using the X25640 is that you must use a power-supply bypass capacitor of approximately 0.1 µF. This is so important that I'll repeat

it later. The reason that bypassing the X25640 is critical probably stems from the way that EEPROMs store data, and from the serial interface.

When an EEPROM writes data, it must generate an internal high programming voltage in order to store the digital 1s and 0s as electrical charges trapped in its storage

cells. Remember that these charges must be trapped like fossilized bugs in amber in order to be detectable 100 years from now! It seems likely that an internal charge pump generates these voltages and puts additional demands on the power supply. By the way, this high-voltage programming process can take as long as 10 milliseconds to complete; another minor disadvantage of EEPROMs.



Connections to BASIC Stamp I/O pins

FIGURE 1. A three-wire connection is all that's required to get 8kB of storage for your BASIC Stamp or PIC applications.

Listing 1

```

Program: XICOR8K.BAS
' This program demonstrates subroutines for storing data in a
' XICOR X25640 serial EEPROM.

Symbol CS      = 0      ' Chip-select line to pin 0.
Symbol CLK     = 1      ' Clock line to pin 1.
Symbol DATA   = pin2   ' Destination of Shout; input to Shin
Symbol DATA_N = 2      ' Pin # of DATA for "input" & "output"
Symbol ReadEE  = 3      ' EEPROM opcode for read.
Symbol WREN    = 6      ' EEPROM opcode to enable writes.
Symbol WRDI    = 4      ' EEPROM opcode to disable writes.
Symbol RDSR    = 5      ' EEPROM opcode to read the status register.
Symbol WriteEE = 2      ' EEPROM opcode for write.
Symbol i       = b6     ' Counter for shift loops
Symbol EEdata  = b4     ' Data byte to/from EEPROM
Symbol EEaddr  = w1     ' 16-bit EEPROM address.
Symbol Shreg   = b1     ' Shift register used by Shin/Shout.

' Beginning of demonstration program. We're just going to write-enable
' the EEPROM, write a value to one of its addresses, then retrieve
' that value.

Demo:
  output DATA_N      ' Output to EEPROM data lines.
  high CS             ' Deactivate EEPROM.

' This chunk of code sends the write-enable opcode to the EEPROM.
' To disable writes, use this same code, but substitute WRDI for WREN.
  let Shreg = WREN    ' Write-enable opcode.
  low CS             ' Activate the EEPROM.
  gosub Shout         ' Send the opcode.
  high CS             ' Deactivate the EEPROM.

' =====
' Now write some data to the EEPROM. The legal range of addresses
' is 0 to 8191.
  let EEdata = 195    ' Sample data.
  let EEaddr = 800    ' Set an address.
  gosub EEwrite       ' Write the data.
  pause 10            ' Wait for write cycle to finish.
  gosub EEread        ' Read back the data.
  debug EEdata        ' Show us.

here:
  goto here          ' Endless loop to terminate program.

' =====
' The subroutines for reading and writing the EEPROM.
' =====

' Shift data into Shreg.
Shin:
  input DATA_N      ' Change the data line to input.
  let Shreg=0        ' Clear data byte.
  for i = 1 to 8     ' Prepare to get 8 bits.
    low CLK          ' Data valid on falling edge.
    let Shreg=Shreg*2 ' Shift Shreg to the left.
    let bit8=DATA    ' Move data to lsb of variable.
    high CLK         ' End of clock pulse.
    next i           ' Get another bit.
  output DATA_N     ' Restore data line to output.
  return

' Shift data out of Shreg.
Shout:
  for i = 1 to 8     ' Shift out 8 bits.
    low CLK          ' Clear clock bit.
    let DATA=bit15  ' Get bit 7 of Shreg.
    let Shreg=Shreg*2 ' Shift register to the left.
    high CLK         ' Data valid on rising edge of clock.
    next i           ' Send another bit.
  return

' Write EEdata to EEaddr.
EEwrite:
  let Shreg = WriteEE ' Set up the write opcode.
  gosub Send_addr     ' Send it and the address.
  let Shreg = EEdata  ' Now send the data.
  gosub Shout         ' Deactivate the EEPROM.
  high CS
  return

' Read data at EEaddr and put it into EEdata.
EEread:
  let Shreg = ReadEE  ' Set up the read opcode.
  gosub Send_addr     ' Send it and the address.
  gosub Shin          ' Now get the data.
  let EEdata = Shreg  ' Transfer from Shreg to EEdata.
  high CS             ' Deactivate the EEPROM.
  return

' Send the opcode and address for write or read.
Send_addr:
  low CS             ' Activate the EEPROM.
  gosub Shout        ' Send opcode in Shreg.
  let Shreg = b3      ' Send upper byte of address.
  gosub Shout
  let Shreg = b2      ' Send lower byte of address.
  gosub Shout
  return

```

Software Interface

From a software standpoint, using the X25640 boils down to this:

- (1) Activate CS by taking it low.
- (2) Shift an instruction (opcode) into the X25640 telling it what you want to do.
- (3) If you are reading or writing a memory location, send the address.
- (4) If you are reading data, shift it into the controller (PIC or Stamp).
- (5) If you are writing data, shift it out to the X25640.
- (6) Deactivate CS by making it high.

Listing 1 shows these processes in detail.

Shifty Characters

In the previous description, I used the term "shift" to mean "move data" without any further explanation. I wanted to give you an overview of the process of communicating with the EEPROM before getting down to the nitty-gritty of synchronous serial communication.

"Synchronous" serial is distinguished from "asynchronous" serial (like RS-232) by the use of a separate clock line. Asynchronous serial requires that both the sender and receiver be set to the same speed, referred to as the bit rate or baud rate. The sender transmits a start bit, which the receiver uses as

a point of reference for the arrival of subsequent data bits. It waits one bit time (1/baud) for each bit.

The receiver and transmitter must agree closely on timing, or else the data becomes garbled. As a result, devices that use asynchronous serial links are designed with a fair amount of timing "slop" to allow for variations in the clock rates of the transmitter and receiver. The slop forces them to run more slowly than the peak potential of the hardware.

Synchronous serial connections virtually eliminate the slop by using the clock line as a point of reference for each bit. With an unambiguous data-now-good signal for every bit, the sender and receiver don't have to agree on timing at all. Bits can be spaced as far apart as one a week, or as close together as the maximum speed of the hardware will allow, often one million per second or more.

The reason this clock-referenced method of sending data serially is called "shifting" is that it is based on a type of component called a "shift register." In this component, a clock line triggers a line of serially connected flip-flops to move the bit at their inputs to their outputs. The first flip-flop acquires a new bit at its input, and the rest of the flip-flops shift old bits down

Listing 2

```

Program: STR2DEMO.BAS
' This program demonstrates how easy it is to write and
' read the 8kB EEPROM via the Stamp Stretcher II.
' Note: because we're writing a lot of data using a
' relatively slow data transfer (16.8 ms per byte total)
' it takes almost 3 minutes to finish the write operation
' and start reading back.

' First, fill each memory location with consecutive
' numbers from 0 to 255.
for w1 = 0 to 8191
  serout 0,n2400,("!",b2,b3,b2) ' w1 consists of b2 and b3.
  ' Write the value of b2 to addr w1.
next w1 ' Next address.

' Now read back the previously written data. This is
' fairly boring, so you may terminate this display at any
' time by pressing a key.
for w1 = 0 to 8191
  serout 0,n2400,("@",b2,b3) ' Send the address.
  serin 0,n2400,b2           ' Receive the data.
  debug b2                  ' Display on PC screen.
next w1                     ' Next address.

' Endless loop to stop program.
here: goto here

```

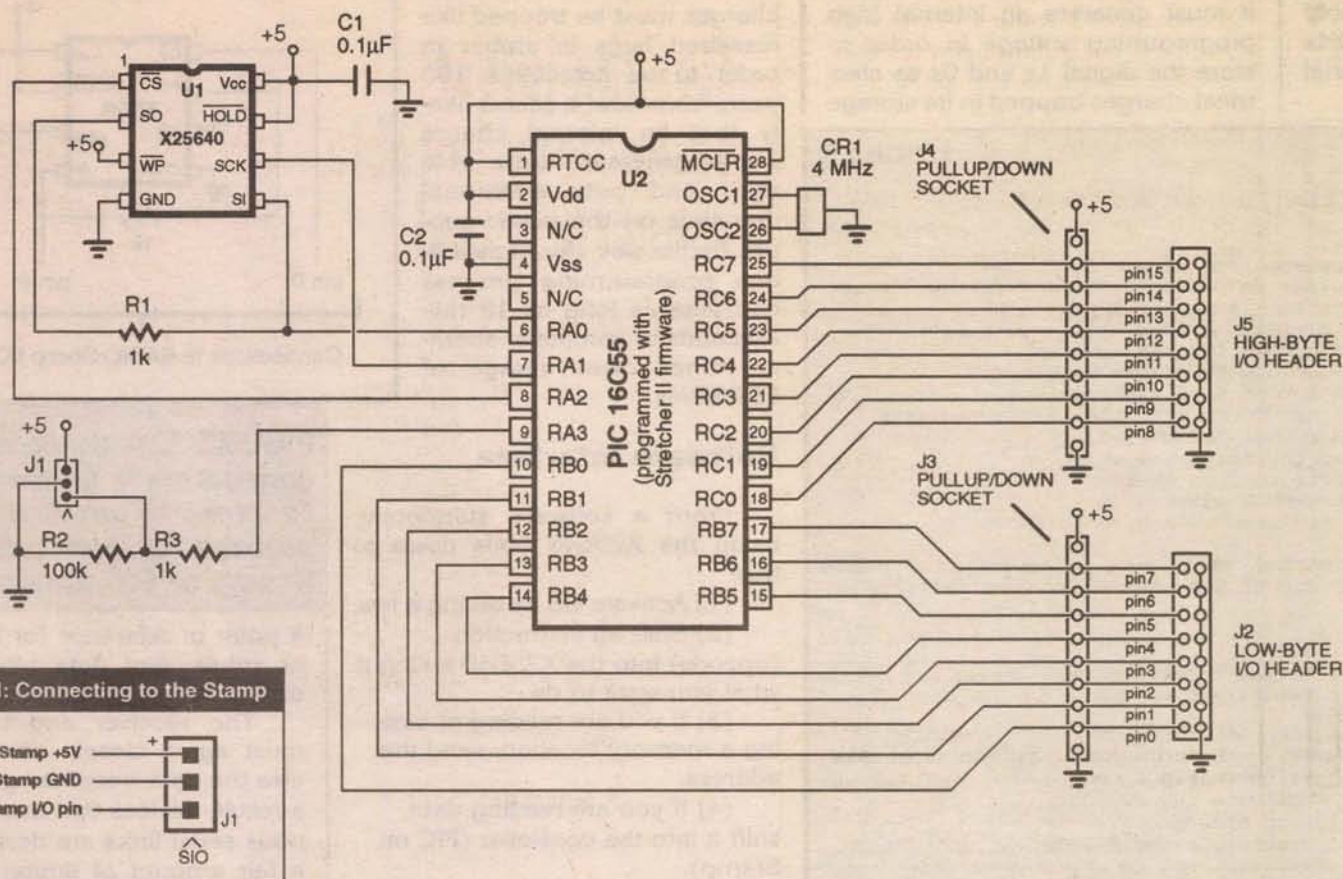



FIGURE 2. Schematic diagram of the Stamp Stretcher II.

the line. At any time, you can stop the clock and examine the outputs of the flip-flops to get a history of the bits found at the input when the clock triggered a shift.

This turns out to be a fast and error-free method of communicating with peripheral components. It's not as fast as a parallel interface, in which all bits are presented at once, but the saving in wiring and package size are often worth it. For example, the 2864 parallel interface EEPROM has the same

8kB capacity as the X25640, but comes in a humongous 28-pin package. Not only is the size objectionable, the part also takes valuable controller resources in the form of I/O lines. For example, the BASIC Stamp with its eight I/O lines simply could not talk to a 2864.

Applying the X25640

Figure 1 shows how to connect the X25640 to the Stamp for the demo program. (A PIC program to drive the X25640 is available from the source in the parts list.

Extensive comments makes it too long to present here.)

Do not omit the bypass capacitor — not even if you feel that your power supply is solid and well-filtered. Locate that cap as close as practical to the supply leads of the X25640. If you omit the bypass cap, you are almost certain to have intermittent communication with the X25640, especially during and after write operations.

This point was driven home to me when a breadboard set-up stopped working. It would work for a while, fail during write operations, then work okay. It seemed to take two tries to write data to the part. I

checked out everything with a meter, scope, logic analyzer — it all looked fine. By chance, I discovered that one lead of the bypass cap wasn't seated in its socket. I fixed it, and the problems vanished.

Listing 1 shows how to program the BASIC Stamp to interface with the X25640. As a demonstration, it writes a byte to an address in the EEPROM's 8kB memory space, then reads back that address to show that the byte was successfully stored. Since virtually everything is done with sub-routines, you should have little trouble modifying the program for your own applications.

A Canned Solution

Good as it is, the Stamp program still consumes a fair number of resources: three I/O lines

and just short of half the Stamp's program memory. In many cases, that's an acceptable price to pay for the additional storage. If it's not too much for your application, I have a canned solution waiting; the Stamp Stretcher II.

You may recall the stamp Stretcher I from the Sept. '94 of *NEV*. It's an accessory that provides 16 additional I/O lines for the Stamp at the expense of one Stamp pin and typically one line of BASIC code per instruction. The Stretcher I also included an analog-to-digital converter (ADC).

The Stamp Stretcher II (Figure 2) substitutes the X25640 for the ADC. To read or write the EEPROM requires just one or two lines of Stamp code. Assuming the Stretcher II is connected to Stamp pin 0, here's how to write the value 99 to EEPROM address 1013 (03F5 hex):

```
Serout 0,N2400,("!", $F5,$03,99)
```

To read the same address back and put the result into variable b2 takes two instructions:

```
Serout 0,N2400,("@", $F5,$03)
Serin 0,N2400,b2
```

You may be wondering where the command symbols for write ("!") and read ("@") came from. They're not standard BASIC commands. Since the Stretcher's command set already included operations for writing and reading its I/O pins, the obvious symbols "R" and "W" were already taken. I borrowed the exclamation point and at sign from the Forth programming language. Maybe the way to remem-

Parts List

U1 — Xicor X25640 8kB serial EEPROM (see note below for source)

U2 — Microchip Technology PIC16C55/XT programmed with the Stretcher II firmware (see note below for source)

CR1 — 4 MHz ceramic resonator with built-in capacitors (Digi-Key PX400)

J1 — 3-pin section of single-row male header (cut from Digi-Key S1012-36-ND)

J2, J5 — 16-pin section of dual-row male header (cut from Digi-Key S2012-36-ND)

J3, J4 — 10-pin strip of SIP header socket (cut from Digi-Key A208-ND)

R1, R3 — 1K, 1/4-watt resistor

R2 — 100K, 1/4-watt resistor

C1, C2 — 0.1uF, 50-V disc or monolithic capacitor (0.1-inch lead spacing)

Miscellaneous — BASIC Stamp; premade Stretcher II circuit board or printed circuit board supplies

Notes: The BASIC Stamp is available for \$39.00 from Parallax Inc., 3805 Atherton Road #102,

Rocklin, CA 95765; phone 916-624-8333. Contact them for a catalog of Stamp and PIC tools and accessories.

Components and kits for the Stamp Stretcher II are available as follows:

U1 Xicor X25640 8kB serial EEPROM chip only (no documentation), part #IC-X25640, \$11.00.

U1 X25640 AppKit (chip as above, plus instructions and 3.5" disk with Stamp and PIC source routines), part #AK-X25640, \$20.00.

U2 PIC16C55/XT programmed with the Stretcher II firmware, part #STII_PIC, \$10.00.

Printed circuit board for Stretcher II, part #STII_PCB, \$15.00.

Complete kit of parts for the Stamp Stretcher II, part #STII_KIT, \$36.00.

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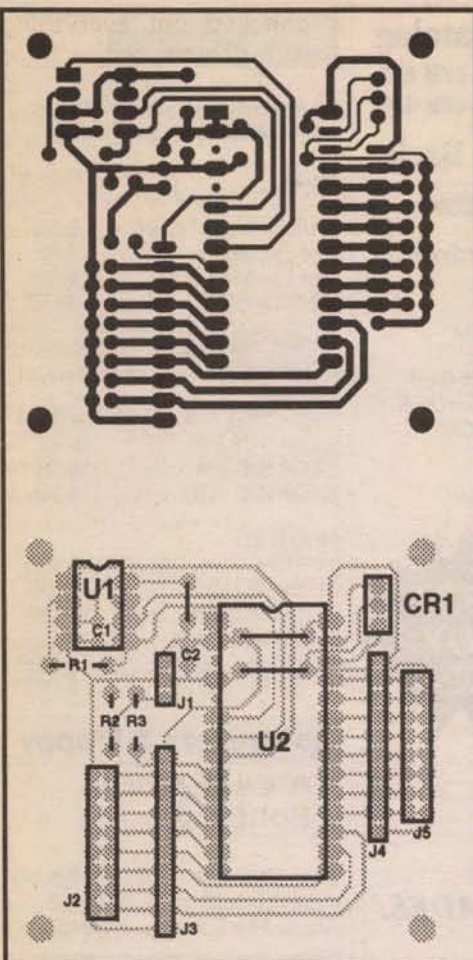


FIGURE 3. Actual size printed circuit board pattern and parts placement diagram. (Note that C1 mounts under U1 and that two jumpers go under U2.)

ber these symbols is:

"!" as in "Write this here!"

"@" as in "What's at (@) this location?"

the program then reads back those stored values. Not very exciting, but it demonstrates successful storage of the data.

Construction

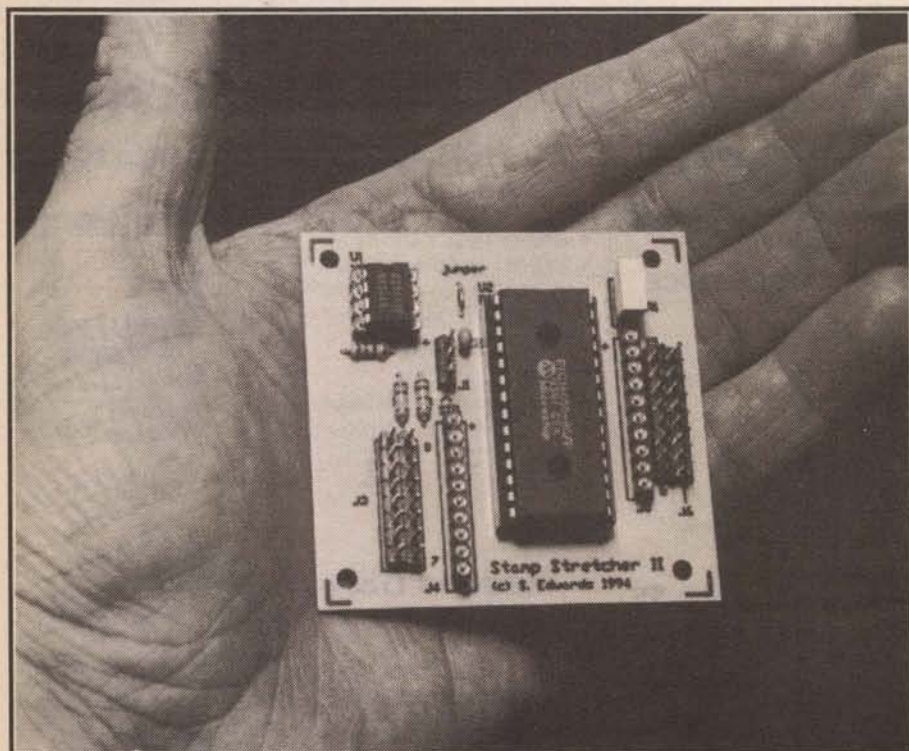
Putting the Stretcher II together is primarily a matter of installing the components at the locations marked on the circuit board and indicated in Figure 3. The only special requirement is that the ICs be mounted in sockets to allow installation of parts (C1 and the wire jumpers) underneath them, and to facilitate replacement, if it ever becomes necessary.

Using the Stretcher II

The custom chip and part kits in the parts list come with instructions for using the Stretcher II, so I won't repeat that material here. Suffice it to say that the Stretcher II includes all of the capabilities of the first Stretcher — reading and writing any or all of the 16 I/O pins, setting and modifying their input/output directions — minus the ADC, plus the EEPROM.

Summary

The part that I call "The X Files" is a versatile storage device for a respectable amount of data. If you used it to record a temperature reading once a minute, the EEPROM would hold more than five-and-a-half days worth of data. Add to that the secu-

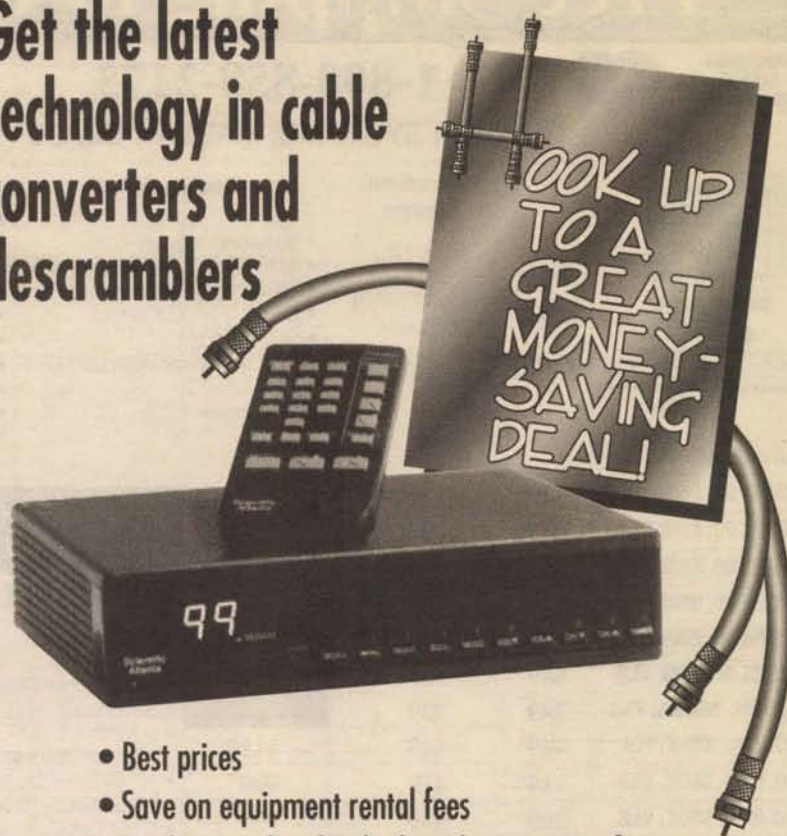


AUTHOR'S PROTOTYPE OF THE STAMP STRETCHER II

Listing 2 presents a demo PBA-SIC program to drive the Stretcher II. It loops through all of the EEPROM's 8192 storage locations writing sequential values from 0 to 255 over and over. When it's done,

rity of knowing that your data won't be lost in the event of a battery failure and that it'll remain intact for a century, and you've got a winner. Even if it is alien technology. **NV**

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- IDE/IO 1P251G Ports
- SVGA Card
- 14" Color SVGA Monitor 0.28
- MS-DOS 6.2
- MS-Windows 3.11

Family Value System

- Practice System With:
- Sony 2 x Speed CD-ROM
- 16 Bit Sound Blaster Card
- Speakers
- Fax/Modem 96/24
- DOS 6.2 & Windows 3.11
- Prodigy/America on Line
- Windows Fax/Modem
- Windows Sound Mixer
- 4 CD ROM Titles

Deluxe Multimedia System

- Barebone System With:
- Medium Tower Case
- 8Mb of Fast Page RAM
- 420Mb IDE Hard Drive
- 1Mb SVGA 1024 x 768 Card
- 14" Color SVGA Monitor 0.28DP
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- DOS 6.2 & Windows 3.11

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PENTIUM 90, 256k VLB	1150	1249	1789
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PENTIUM 66, 256k VLB	729	809	1369
PENTIUM 60, 256k PCI	729	819	1379
PENTIUM 60, 256k VLB	689	769	1329
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1139	1449
1119	1429
1099	1399
1039	1339
1049	1359
1029	1339
1019	1319
1009	1309
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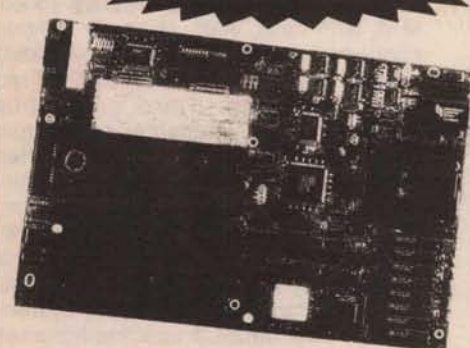
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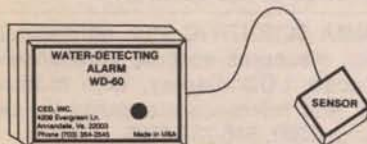
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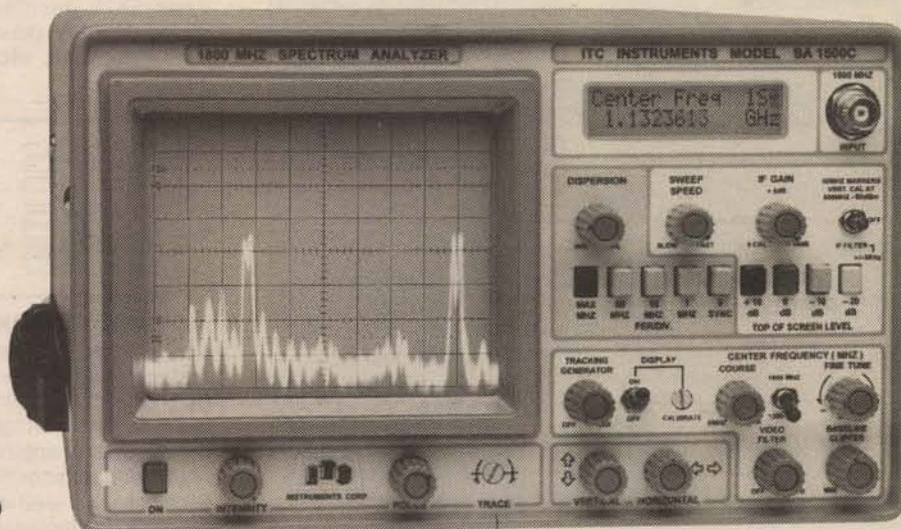
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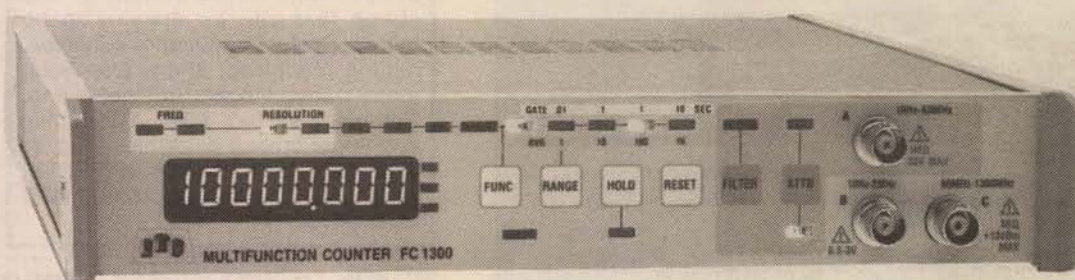
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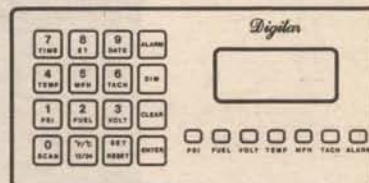
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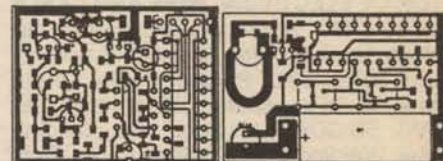
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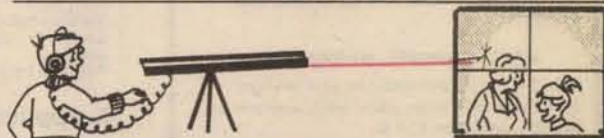
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TOYS are more than just a pacifier or past-time for children to while away idle moments. They're a means of exploring and learning. They may help in developing social skills, imagination, and creativity. Of course, there's an abundance of com-

mercially produced toys (and some very good ones), but, who says the kids must have all the fun?

Can the average electronics hobbyist accomplish a feat worthy of the "mad scientist" role in a bad science-fiction movie? Sure, you can have a monster with personality. I don't know if it can "feel your pain" as some politicians claim to do, but it sure can sense pressure. Feedback is immediate. It won't hold it all inside, then emotionally blow up on you in the middle of heavy traffic on the freeway.

When resting and at peace with its surroundings, the monster emits an erratic ticking sound. It's a sound you might associate with Geiger counters indicating radioactivity.

Squeeze the right place and one of the voices will increase the rate of the ticking sound until it

sounds like a low buzz. Squeeze harder and the pitch increases to sound out a tone. Squeeze really hard and the pitch increases to a squeal. The three voices are mixed in a way that forms additional frequencies. If you massage several areas at once, some weird sound effects are generated.

You probably know of or will learn about the black foam plastic material used for ESD (electrostatic discharge) protection. It's often used for packaging and shipping various semiconductor devices.

A common and versatile building block of many analog circuits is the integrated-circuit op-amp or operational amplifier. What do these two apparently unrelated topics have in common? With a handful of other parts, they form the behavioral characteristics of the Feely Monster.

For the uninitiated, I have some brief and somewhat simplified observations about op-amps. After that comes details about this unusual use for the conduc-

THE

Feely Monster

by Randy Henderson

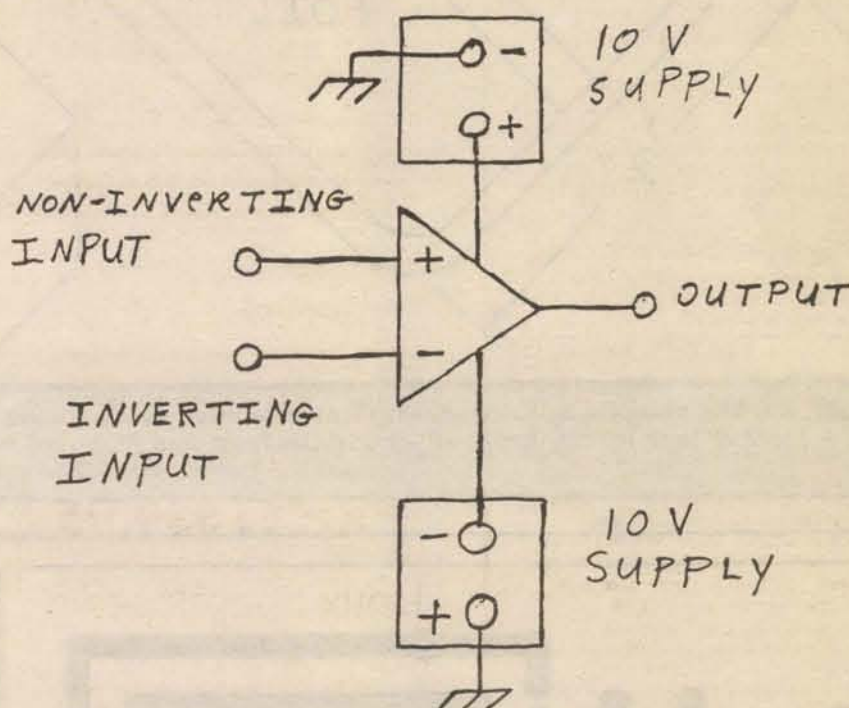


FIGURE 1 — Input signals are applied between each input pin and ground. In a perfect op-amp, the output would remain at zero if both inputs see exactly the same voltage. With no feedback present, the circuit is said to be operating in an open-loop condition.

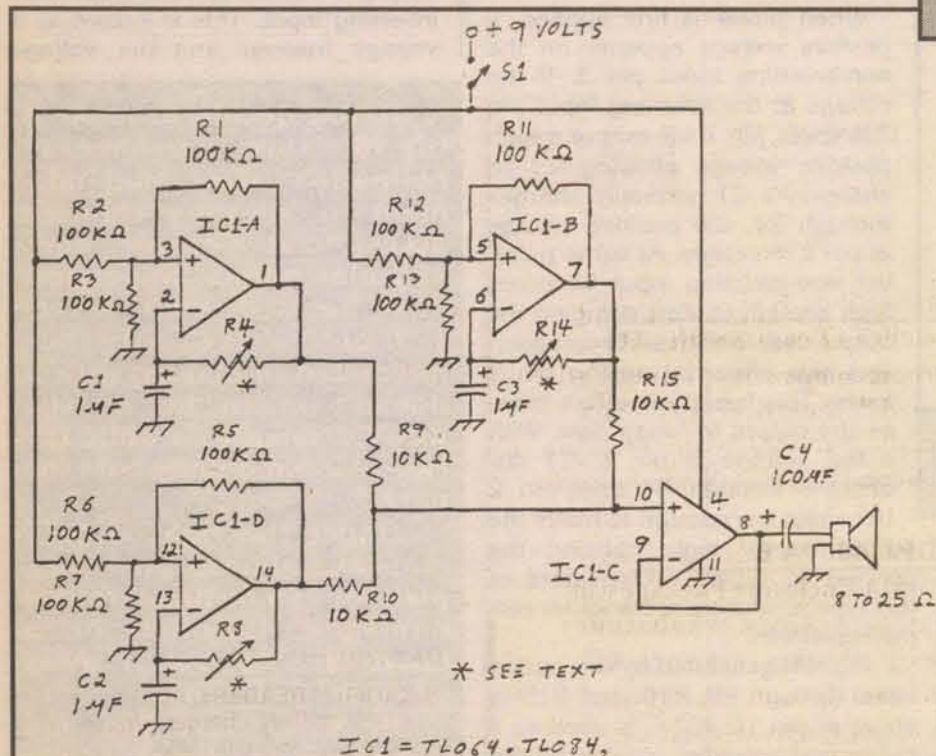


FIGURE 2 — IC1-A, -B, and -C are used as oscillator circuits. The frequency of oscillation is varied by transducers R4, R14, and R8 respectively.

tive foam plastic as a force sensor.

Operational Amplifiers

An op-amp is a type of high-gain DC linear amplifier. A small voltage change at the input can

cause changes thousands of times as large at the output terminal. The difference in voltage (with respect to common or ground) between the inputs is amplified by the gain inherent in the op-amp itself.

If the gain in Figure 1 is say, 100,000, then a difference of only

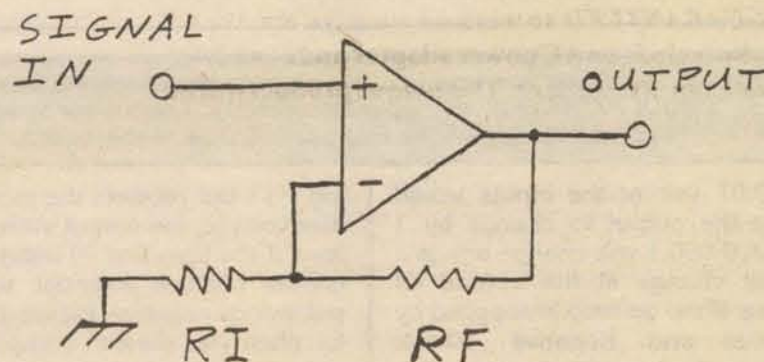


FIGURE 3 — By using negative feedback in a closed loop, the amount of amplification or gain can be predicted. $GAIN = 1 + R_F/R_I$.

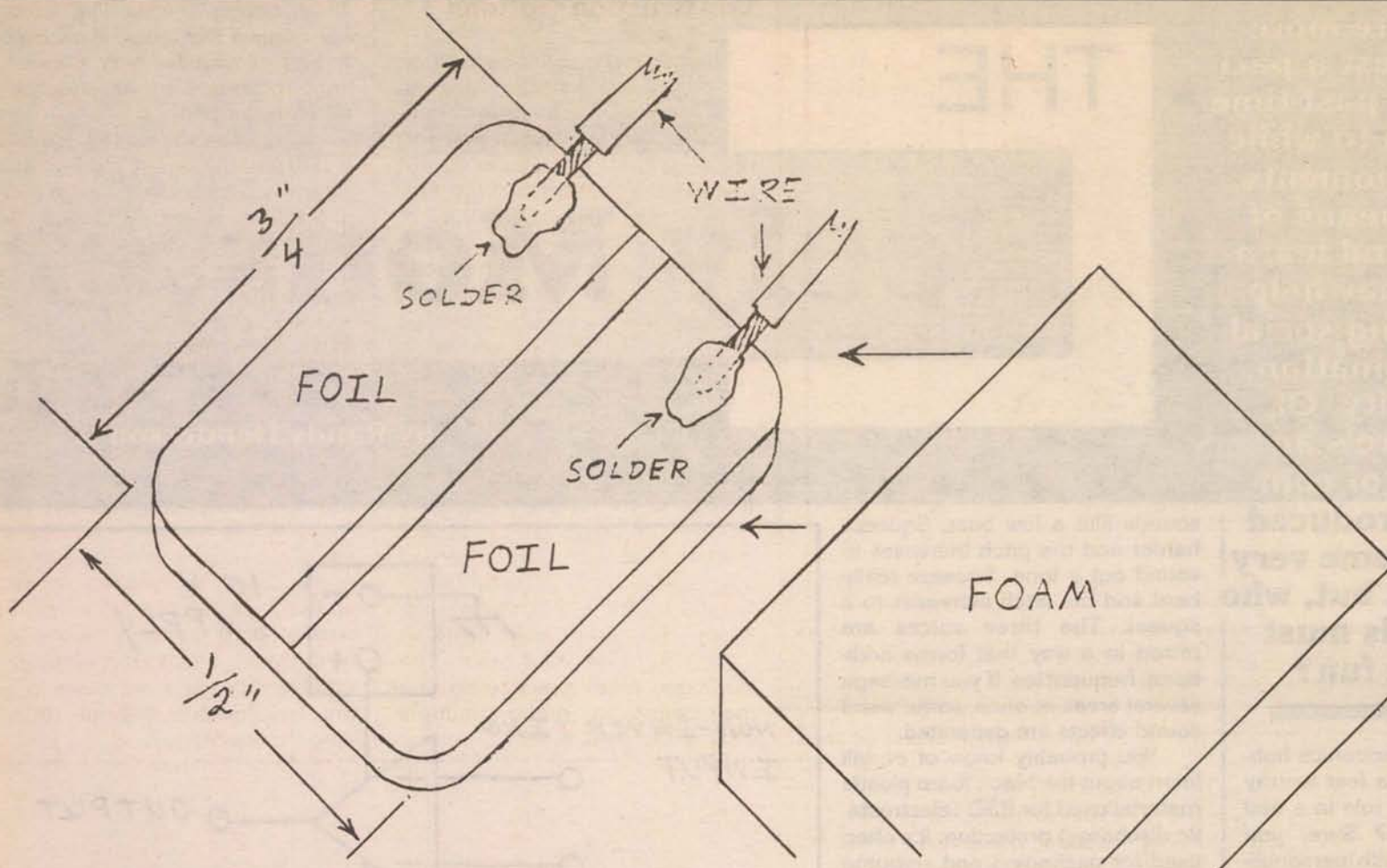


FIGURE 4 — The pressure or force sensing transducers are very simple. These are the dimensions I used, but they're not critical. A piece of tape loosely wrapped around the foam and PC-board material holds it all together. High resistance is 2 to 5 megohms. Low resistance is about 500 ohms.

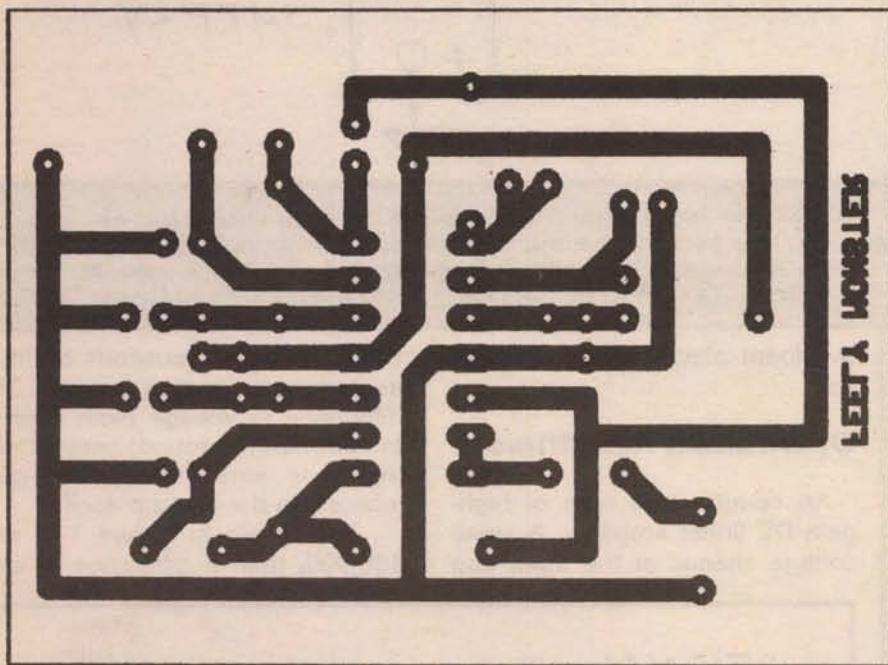


FIGURE 5 — When you iron this image onto the blank PC board, the words "FEELY MONSTER" will appear correctly. The mirror image means you are looking at the component side of the board.

0.000,01 volt at the inputs would cause the output to change by 1 volt. A 0.000,1 volt change brings a 10-volt change at the output. Of course, if the op-amp is supplied by positive and negative 10-volt sources, that's as large as the output changes can be. Even larger input differences cause the output to "slam" back and forth between the aforementioned limits.

For instance, if the non-invert-

ing (+) input receives the more positive voltage, the output swings positive. If the inverting (-) input is at a greater positive potential, the output swings negative. Figure 1 is useful when you want to compare two voltages. It becomes a sort of voltage-sensing "switch." When used this way, it's called a comparator.

Some of the op-amps in this project are used to compare the voltage of a charging capacitor to a

portion of the output voltage. In Figure 2, IC1-A, -B, and -C are used in this manner. All three sections are similar so let's look at IC1-A.

A single battery supplies power. Instead of the ground or common used in Figure 1, an artificial reference point is used where R2 and R3 meet forming a voltage divider.

When power is first applied, a positive voltage appears on the non-inverting input pin 3. If the voltage at the inverting input pin 2 is lower, pin 1 will output a high positive voltage allowing C1 to charge. As C1 gradually charges through R4, the positive voltage at pin 2 increases. At some point, the non-inverting input becomes high enough to start swinging the output less positive. R1 exaggerates this effect by pulling pin 3 lower. This hysteresis effect causes the output to "snap" low. With a low voltage at pin 1, C1 discharges through R4 until pin 2 becomes low enough to make the output "snap" high, causing the process to repeat. Oscillators of this type produce a rectangular output waveform.

Signals generated by this action travel through R9, R10, and R15 to arrive at pin 10. IC1-C is used as a buffer and amplifier for driving the small loudspeaker.

To be useful as an amplifier, a technique known as negative feedback is used. Figure 3 is an

example of an amplifier with a predictable and stable amount of gain. The amount of amplification is determined by the external resistors, not by the particular op-amp that happens to be in use.

When trying to visualize what happens, remember voltage differences between the input terminals must be very small to keep the output within a usable range. Feeding back a portion of the output signal to the inverting input tends to reduce the difference between inputs.

The amplifier stage used here to drive a small speaker is a kind of special case where the full output voltage is fed back. For

instance, when the non-inverting input swings positive, the inverting input opposes this move because it's tied directly to the output terminal. The output can't become more positive than the non-inverting input signal because that would make the inverting input the most positive input (moving the output in the wrong direction). Therefore, the output is forced to follow the non-inverting input. This is known as a voltage follower and the voltage

If you decide to make a toy like this, you have an obligation to use good judgment in allowing children access to it. Consider ages and play habits. Supervise. Just because your seven-year-old is the only one interested in playing with it doesn't mean he or she won't dismantle it while the two-year-old quietly eats the parts!

Under the right circumstances, almost any complex toy can be dangerous if damaged. It might be a good idea to put it away when it's not in use.

Be safe. Have fun and watch out for those adults who can't seem to keep their hands off of your monster!

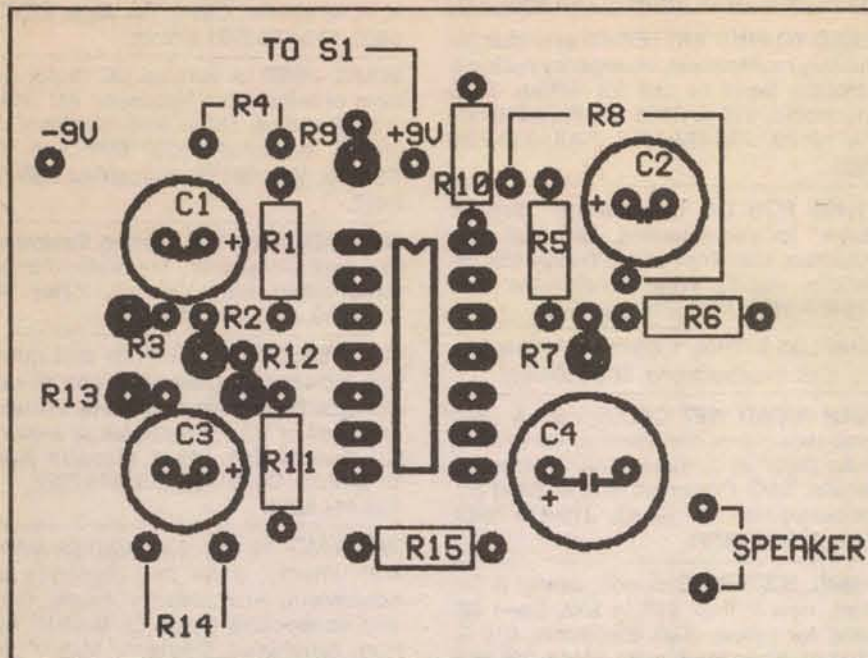


FIGURE 6 — Here's the component layout. Be sure to observe the polarity symbols on the capacitors.

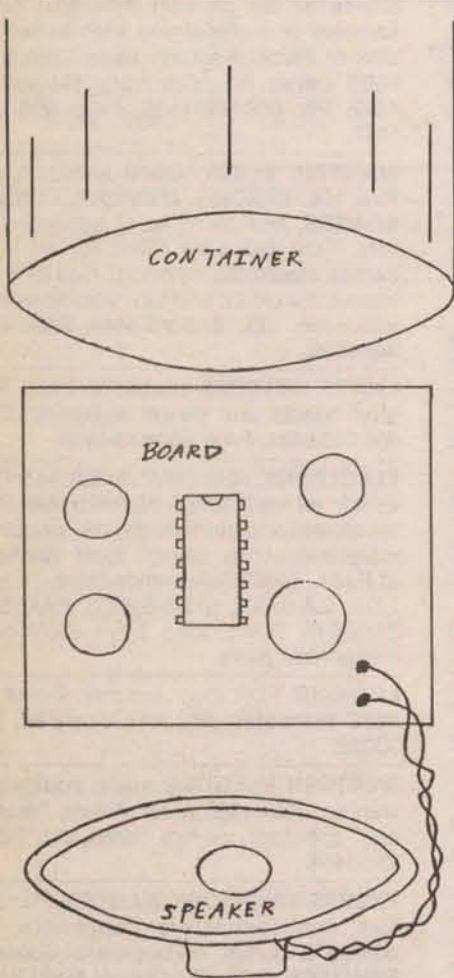


FIGURE 7 — I commandeered the plastic cap from an aerosol spray can for the container. A hole through the container and board allows it to be fastened with a single screw and nut. Ridges molded into the cap interior keep the speaker away from the board.

gain is unity. Power gain occurs because the output terminal can supply much more current to the load than the current flowing into the non-inverting input terminal.

The number of possible uses for op-amps is great and they are inexpensive and easy to experiment with. After you have unleashed

another Feely Monster upon the world, you may want to continue your fiendish experiments. Lots of educational material is available and a few simple (hey, really) mathematical principles can be used for applying many of the circuits.

Pressure Sensors

Okay, so what's the big mystery about the ESD protective foam? In addition to being conductive, the conductance or resistance (depending on how you want to view things) can be varied over a wide range by simply compressing or releasing the material.

Figure 4 shows how small chunks are fashioned into very inexpensive mechanical-force transducers. Of course, it was never designed for such applications, so please don't call your local parts supplier and burden them with the fact that you practically had a bovine birth experience because of unexpected results.

The conductivity of the stuff varies between brands and types. Parts are often packed in it. The material that gives my Feely Monster its "sense of touch" protected some semiconductors that I ordered from Newark Electronics.

Each oscillator has a frequency range of roughly 2 Hz to more than 1000 Hz. If you don't achieve the desired effect, you can try other ESD foam, or change the values of C1, C2, and C3.

Construction Options

The original circuit was built on perforated board stock. This is an easy project to build on perf-board if you are adept at that sort of thing. There is an easy way to transfer the pattern in Figure 5. Have a transparency made of it. Local copy services can do this. Make sure you specify it has solid blacks. Take it home. Plug in a clothes iron (yes, I said clothes iron). Set the temperature range to linen and preheat the un-etched board.

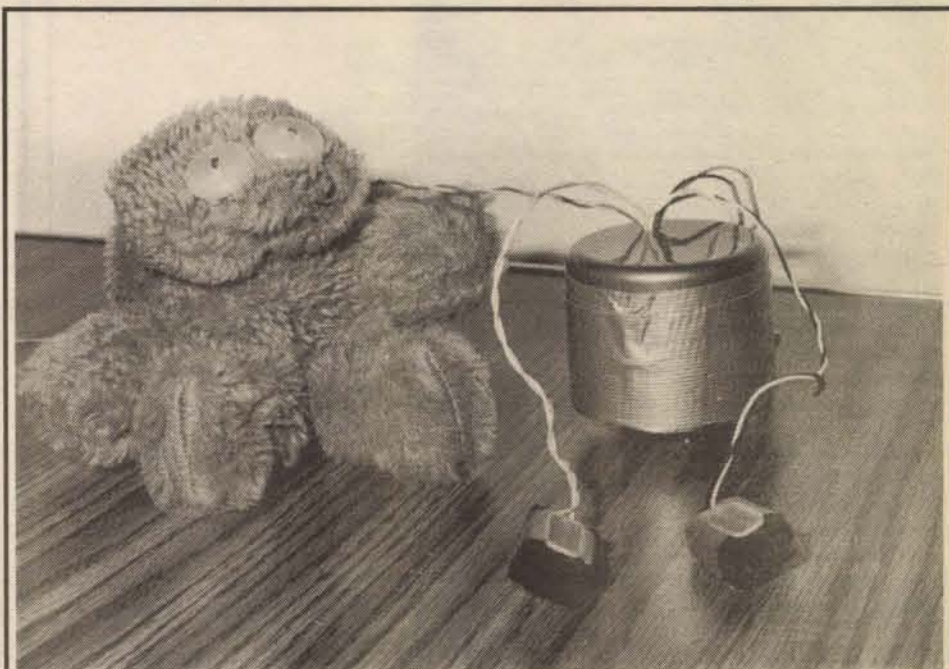
Next, lay the transparency, toner side down, on the board. Place one sheet of paper over the transparency. Iron the transparency onto the board. The toner will melt and stick to the board. Let the board cool completely. Carefully peel the transparency away. This should leave toner on the board to act as a resist. The technique takes practice so you may want to make multiple copies of the pattern.

A strong solvent like acetone will remove the toner, if necessary. A perfect transfer isn't necessary. Imperfections can be touched-up with a resist pen.

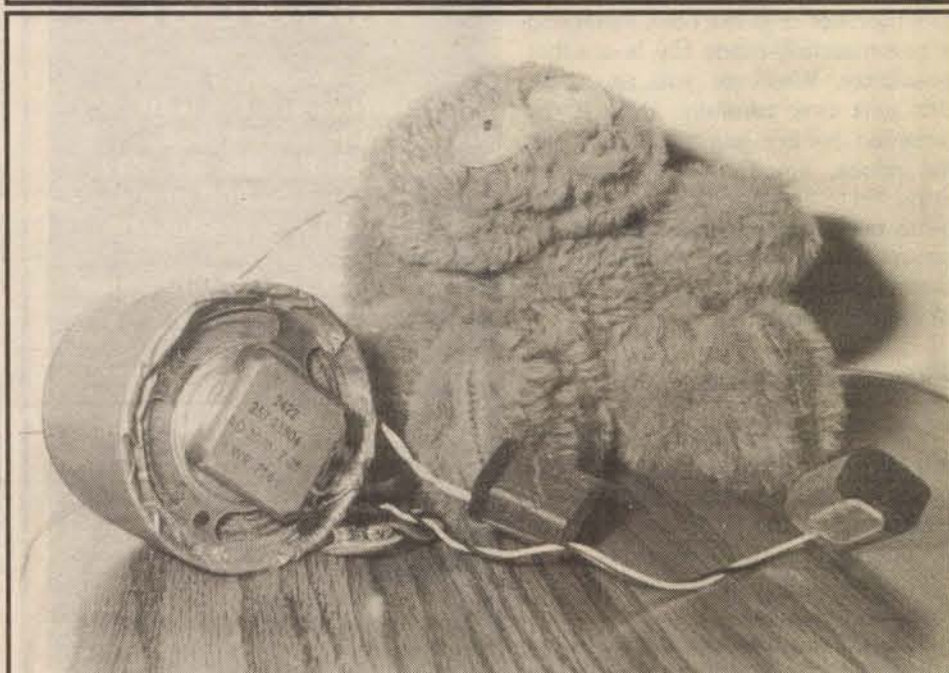
After you've etched, cleaned, and drilled the board, simply mount the components as shown in Figure 6. It might be a good idea to use a socket for IC1. Should replacing it be necessary, the job will be a lot easier.

Monster Innards

Now for the fun part. Figure 7 has information on how I packaged the electronics, but if you have other ideas, use them. Our resident monster was designed by yours truly. It has transducers fitted into the arms head and belly. The eyes are attached securely to the head so that they can't be pulled off. Two strong metal fasteners at the back of the neck secure the battery. All other inside parts are sewn in and are inaccessible without dismantling the stuffed toy.



Feely Monster approaches transplant operation with good attitude.



Feely Monster deep in thought after being told the sound producing speaker will be located in his posterior.



Whoa! How about some anesthesia here?



Everything is inside now. A few more stitches, a couple of fasteners, and were ready to close.

Of course, you don't have to become a masochistic tailor of miniature monster suits like I did. Modifying a commercially-made toy is another possibility. Whatever you do, think this part over carefully. Even if the intended use is a gag gift or curiosity for adults, small children may be attracted to it. A good objective might be to make everything so strong and secure that you have to literally rip the critter apart to gain access to any of the electronics.

Monster Musing

In this age of genetic engineering, it only seems fitting that we have new imaginary creatures to compliment the increasing variation and diversity in real ones.

Of course, a monster that can feel and vocalize is sure to be accepted as having appropriate social behavior in this decade of the 90s. Oh, and reproductive behavior? Well, that depends on the readership. Happy monster making. **NV**

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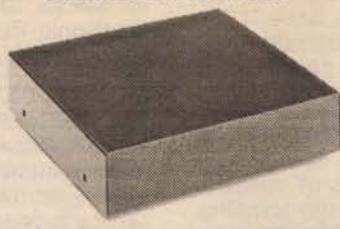
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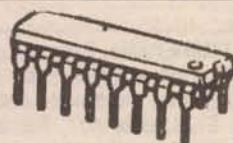
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DECEMBER 17

IN - MERRILLVILLE — Computer Possibilities Unlimited. **SPONSOR:** Bee Software. **LOCATION:** Michelangelo Hall, 6220 Broadway. **HOURS:** 10am-3pm. **ADMISSION:** \$5, under 12 free. **FEATURES:** AC - C - DP - FP - F/R - S. **CONTACT:** Info/Discount tickets: 219-931-3761.

MI - ROSEVILLE — International Canadian/American Mega-Fest Show. **SPONSOR:** E.S.P.S. Corp. **LOCATION:** Days Inn Hotel, 31960 Little Mack. I-94 to Gratiot, go to Masonic, make right, 1/4 mile on right. **HOURS:** 10am-4pm. **ADMISSION:** \$4. **FEATURES:** C - CB - H. **DEALER INFO:** Setup 8am-9:45am. **CONTACT:** John or Sabrina, Bus: 313-884-7690/FAX.

MI - WESTLAND — Great Lakes Computer Expo & Sale. **SPONSOR:** Progressive Computer Productions. **LOCATION:** Wayne-Ford Civic League, 1645 Wayne Rd. I blk S of Ford Rd. **HOURS:** 10am-4pm. **ADMISSION:** Adults \$4, Seniors/Students \$3, under 12 free w/adult. **FEATURES:** C - DP - FP - F/R - S. **DEALER INFO:** 8' \$30 ea., 12' \$40 ea. **CONTACT:** Progressive Computer Productions, 23814 Michigan Ave., Ste 237, Dearborn MI 48124. 313-425-9276.

OH - CLEVELAND — Compvter Mania. **SPONSOR:** National Computer Exposition. **LOCATION:** Clarion Hotel/Eastlake, 35000 Curtis Blvd. at Rt. 2 & Rt. 91. **HOURS:** 10am-4pm. **ADMISSION:** \$1 off w/ad, under 12 free. **FEATURES:** FP. **DEALER INFO:** Setup 8am-10am. Sellouts are common, early booking advised. **CONTACT:** Joe Bowen, 216-442-1776 or Ronald Nelson, FAX: 216-292-7746. National Expo's, Inc., 30799 Pinetree Rd. #230, Cleveland OH 44124.

DECEMBER 18

IL - ORLAND PARK — The Orland Park Computer Show. **LOCATION:** Orland Park Civic Center, 147th St & LaGrange Rd (Rt. 45). **HOURS:** 9:30am - 3pm. **ADMISSION:** Adults \$5 - \$1 off with copy of this ad, 8-12 yrs \$2, under 8 free. **FEATURES:** A - C - CB - DP - FP - F/R - All indoors. **CONTACT:** 24-hour Hotline 708-974-3123.

MI - FLINT — Computer Trade Show. **SPONSOR:** 5 Star Productions. **LOCATION:** Flint Holiday Inn, Gateway Centre, US-23 at Hill Rd. Exit 2 miles S of I-69. **HOURS:** 10am-5pm. **ADMISSION:** \$4, \$3 w/this ad. **FEATURES:** AC - C - CB - DP - FP - F/R. **CONTACT:** Five Star Productions, 810-768-6058 (pager).

MI - TAYLOR — International Canadian/American Mega-Fest Show. **SPONSOR:** E.S.P.S. Corp. **LOCATION:** Holiday Inn, 20777 Eureka Rd. I-75 to Eureka Rd. on E side of Fwy. **HOURS:** 10am-4pm. **ADMISSION:** \$4. **FEATURES:** C - CB - H. **DEALER INFO:** Setup 8am-9:45am. **CONTACT:** John or Sabrina, Bus: 313-884-7690/FAX.

OH - AKRON — Compvter Mania. **SPONSOR:** National Computer Exposition. **LOCATION:** Akron Hilton/Quaker Square, 135 S. Broadway (Downtown). **HOURS:** 10am-4pm. **ADMISSION:** \$1 off w/ad, under 12 free. **FEATURES:** FP. **DEALER INFO:** Setup 8am-10am. Sellouts are common, early booking advised. **CONTACT:** Joe Bowen, 216-442-1776 or Ronald Nelson, FAX: 216-292-7746. National Expo's, Inc., 30799 Pinetree Rd. #230, Cleveland OH 44124.

OH - BOWLING GREEN — Computer Show. **SPONSOR:** CDE Computer Products. **LOCATION:** Wood

County Fairgrounds. **HOURS:** 10am-4pm. **DEALER INFO:** Setup 8:30am-10am. 50 8' tables available at \$35 ea., 4 or more \$25 ea. **CONTACT:** CDE Computer Products, 635 Flanders Ave., Bowling Green OH 43402-1520. 419-352-9316.

OH - TOLEDO — Computer Blowout Sale. **SPONSOR:** MBE Computers. **LOCATION:** Holiday Inn/Southwyck, corner of Reynolds Rd. & Heatherdowns, 1 block N of Ohio Tpke. Gate 4. **HOURS:** 10am-4pm. **FEATURES:** C - FP. **DEALER INFO:** Setup 7:30am-9:30am. \$40 per table, 4 or more tables \$35 ea. Fax inquiries to 517-646-9885. **CONTACT:** For more information call 517-646-9895 or 313-572-0038.

JANUARY 8

WI - WAUKESHA — 23rd Annual Midwinter Swapfest. **SPONSOR:** West Allis Radio Amateur Club. **LOCATION:** Waukesha County Expo Center Forum. **HOURS:** 8am-2pm. **ADMISSION:** \$3 adv., \$4 door. **FEATURES:** EX. **DEALER INFO:** 4' table \$4, \$5 at the door, electrical outlet \$7.50. **CONTACT:** WARAC Swapfest, POB 1072, Milwaukee WI 53201.

JANUARY 21

CO - LOVELAND — Winter Superfest Swap Meet. **SPONSOR:** Northern Colorado ARC. **LOCATION:** Larimer County Fairgrounds, 700 S. Railroad. **HOURS:** 9am-3pm. **ADMISSION:** \$3. **FEATURES:** C - CB - DP - E - EX - FP - F/R - H. **DEALER INFO:** Tables \$8. **CONTACT:** Jeanene Gage, NOYHY, 303-351-7327 for tables; Randy Long, WB6AVV, 303-226-1529 or Musser Moore, AA0PB, 303-221-3698 for general info.

LA - HAMMOND — 14th Annual Hammond Hamfest. **SPONSOR:** Southeast Louisiana ARC. **LOCATION:** Southeastern Louisiana University. **HOURS:** 7:30am-7. **ADMISSION:** Free. **TALK-IN:** 147.00. **FEATURES:** AC - DP - EX - FP. **DEALER INFO:** Tables: Before Dec. 1, \$15 first table, \$10 additional; after Dec. 1, all tables \$15. **CONTACT:** SELARC Hamfest, POB 1324, Hammond LA 70404.

MO - SAINT JOSEPH — Northwest Missouri Winter Hamfest. **SPONSOR:** Missouri Valley ARC, Green-Hills ARC, Ray-Clay ARC. **LOCATION:** Ramada Inn, I-29 Exit 47 (Frederick Ave. Exit). **HOURS:** 9am-4pm. **ADMISSION:** \$2 ea. or 3 for \$5 adv., \$3 ea. or 2 for \$5 at the door. **TALK-IN:** 146.85, 444.925. **FEATURES:** CB - DP - E - EX - F - FM - FP - F/R - H. **DEALER INFO:** 1-2 tables w/2 chairs \$9 ea., 3+ \$20 ea. **CONTACT:** NWMO Winter Hamfest, POB 182, Cameron MO 64429.

JANUARY 22

IL - GLEN ELLYN — Computer Central. **LOCATION:** College of DuPage, Physical Education Bldg. Main Arena, Park Blvd. & College Rd. **HOURS:** 9:30am-3pm. **ADMISSION:** Adults \$6, 8-12 \$2, under 8 free. \$1 off reg. adult admission w/this ad. **FEATURES:** AC - C - FP. **CONTACT:** Computer Central, Jay B. Robinson, 708-940-7547.

JANUARY 29

OH - DOVER — Hamfest. **SPONSOR:** Tusco ARC. **LOCATION:** Ohio National Guard Armory, 2800 N. Wooster Ave. **HOURS:** 8am-4pm. **ADMISSION:** \$2. **TALK-IN:** 146.730/130. **FEATURES:** F/R. **DEALER INFO:** Tables \$8. **CONTACT:** Howard Blind, K8BKF, 6288 Echo Lake Rd NE, New Philadelphia OH 44663. 216-364-5258.

EASTERN REGION

NOVEMBER 5

FL - EUSTIS — Lake County Hamfest & Electronics Expo. **LOCATION:** Lake County Fairgrounds. **HOURS:** 9am-5pm. **FEATURES:** EX. **CONTACT:** Jason Matthews, KE4AUS, 2606 Montecito Ave., Eustis FL 32726. 904-357-9357.

NH - NASHUA — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** Resurrection Center, 1.5 ml. W of Rt. 3 (Exit 6) Rt. 130. **HOURS:** 10am-3:30pm. **ADMISSION:** \$7, 14 & under free w/adult. **FEATURES:** C. **DEALER INFO:** Setup 8am. **CONTACT:** Northern Computer Shows.*

NJ - HIGHTSTOWN — Fall Meet/Auction. **SPONSOR:** New Jersey Antique Radio Club. **LOCATION:** Hightstown County Club, near Exit 8 on NJ Turnpike, off Rt. 33. **HOURS:** 7am-2pm, 11am Indoor catalog auction. **CONTACT:** Mary Beeferman, 609-693-9430, or Ludwell Sibley, 908-782-4894.

NOVEMBER 5-6

FL - MIAMI — COM/BUS Miami Computer & Electronics Show. **SPONSOR:** EDG Enterprises, Inc. **LOCATION:** Youth Fair Exposition Center Coliseum, SW 112 Ave. & Coral Way. **HOURS:** 10am-4pm. **ADMISSION:** \$5 adv., \$6 door. **FEATURES:** C - DP - E - FP - S. **DEALER INFO:** Booth and table inquiries: 305-642-4139, FAX: 305-642-1648. **CONTACT:** EDG Enterprises, Inc., 2780 NW 3rd St., Miami FL 33125.

GA - LAWRENCEVILLE — Stone Mountain Hamfest '94. **SPONSOR:** Alford Memorial Radio Club, Inc. **LOCATION:** Lawrenceville Fairgrounds. **TALK-IN:** 146.76. **FEATURES:** FM - T. **CONTACT:** Hamfest '94, Alford Memorial Radio Club, Inc., POB 1282, Stone Mountain GA 30086-1282.

PA - EASTON — PC Dealer Showcase. **SPONSOR:** StarWare. **LOCATION:** Palmer Park Mall, Rt. 22 to Rt. 248. **HOURS:** Sat: 10am-9:30pm, Sun: Noon-5pm. **ADMISSION:** Free. **FEATURES:** AC - C - FP. **DEALER INFO:** Tables \$95 ea. per day. **CONTACT:** StarWare, 610-584-8770.

PA - FORT WASHINGTON — Computer Show. **LOCATION:** Ft. Washington Expo Center (near Philadelphia), PA Turnpike Exit #26, 1/2 mile to light, turn right and follow signs to Center. **HOURS:** Sat: 10am-4pm Sun: 10am-3pm. **FEATURES:** C. **DEALER INFO:** 500 tables. **CONTACT:** KGP Computer Show.*

NOVEMBER 6

MA - TAUNTON — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** Taunton Holiday Inn, Exit 9 off I-495, between Rt. 24 & I-95. **HOURS:** 10am-3:30pm. **ADMISSION:** \$7, 14 & under free w/adult. **FEATURES:** C. **DEALER INFO:** Setup 8am. **CONTACT:** Northern Computer Shows.*

NC - CONCORD — Hamfest/Swap Meet. **SPONSOR:** Cabarrus Amateur Radio Society. **LOCATION:** Cabarrus County Fairgrounds. **HOURS:** 8am-4pm. **ADMISSION:** \$5 adv., \$6 door, under 12 free. **TALK-IN:** 146.655/055. **FEATURES:** DP - EX - FM - T. **DEALER INFO:** Tables \$10, setup Sat. 3pm-10pm

& Sun. 6am. Info: Bill Hickok, WD8SAS, 802 Williamsburg Dr., Concord NC 28025. 704-788-2873. **CONTACT:** Jeff Parker, WA1WXL, 1630 Eastwood Dr., Kannapolis NC 28083. 704-933-7238.

NOVEMBER 11

NJ - FAIRLAWN — Ham Radio/Computer Auction. **SPONSOR:** Fairlawn ARC. **CONTACT:** Gary, KB2LCA, 201-791-3841 Fri. eves. only.

NOVEMBER 12

AL - MONTGOMERY — 17th Annual Montgomery Hamfest & Computer Show. **SPONSOR:** Montgomery ARC. **LOCATION:** Garrett Coliseum, South Alabama State Fairgrounds on Federal Dr. **HOURS:** 8am-3pm. **ADMISSION:** \$3. **TALK-IN:** 146.24/84, 147.78/18, 449.50/444.50. **FEATURES:** EX - FM - FP. **DEALER INFO:** Setup Nov. 11 3-8pm & Nov. 12 6-8am. **CONTACT:** Hamfest Committee, c/o 111 Diane Dr., Prattville AL 36066 or phone Jiggs at 205-365-0380 or FAX 205-264-1150.

FL - HIALEAH — Hamfest. **LOCATION:** Hialeah Adult Center, Palm Ave. & 6th St. **HOURS:** Noon-5pm. **ADMISSION:** Free. **TALK-IN:** 146.805. **CONTACT:** Greg, KC4IVF, 305-883-5812.

FL - LAKE WORTH — Hamfest. **LOCATION:** Sunset Ridge Park, Ave. A & 13th St. North. **ADMISSION:** Free. **TALK-IN:** 146.670. **CONTACT:** Bill, N4ZDD, 407-439-8796.

FL - ORLANDO — Computer Fair. **SPONSOR:** "We're Show Offs!" **LOCATION:** Holiday Inn, 7900 S. Orange Blossom Trail. **HOURS:** 10am-3pm. **ADMISSION:** Adults \$4, \$3 w/ad, under 12 free. **FEATURES:** AC - C - DP - FP. **DEALER INFO:** \$40/1 table, \$75/2 tables, \$25/ea. **CONTACT:** "We're Show Offs!" 813-545-5265.

MA - PLYMOUTH — 4th Annual Flea Market. **SPONSOR:** Mayflower ARC. **LOCATION:** Plymouth Memorial Hall Building, Plymouth Center (RT3A). **HOURS:** 9am-3pm. **ADMISSION:** \$2, under 12 free. **TALK-IN:** 446.625, 146.685. **FEATURES:** F/R. **DEALER INFO:** Tables \$12 adv., \$14 door. Setup 8am. Send checks to: MARC, POB 766, Dept. FM, Plymouth MA 02362-0766. **CONTACT:** Jon, WS1K, 508-746-0162 or Jim, NM1F, 508-747-2224 (evenings).

PA - HERSHEY — Hershey Hamfest. **SPONSOR:** Central Penna. Repeater Assn. **LOCATION:** Hershey Armory 28th Div. Infantry, Baum St. off 422 on E end of Hershey. **HOURS:** 8am-2pm. **ADMISSION:** \$2.50. **TALK-IN:** 145.47. **FEATURES:** DP - EX - FP - F/R. **CONTACT:** Harold Baer, N3LZH, 619 W. 2nd St. Hummelstown PA 17036. 717-566-8895.

SC - MYRTLE BEACH — Beachfest '94 Hamfest & Computer Show. **SPONSOR:** Grand Strand ARC. **LOCATION:** Myrtle Beach High School. **HOURS:** 9am-4pm. **ADMISSION:** \$5 adv., \$6 door. **TALK-IN:** 147.120+. **FEATURES:** EX. **CONTACT:** Robert Battle, 803-236-2887 or Gordon Mooneyhan, 803-293-3839 or write GSARC, POB 2135, Myrtle Beach SC 29578-2315.

VA - MANASSAS — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Prince William Co. Fairgrounds. **HOURS:** 9:30am-4:30pm. **ADMISSION:** \$6. **FEATURES:** C - FP. **DEALER INFO:** Setup 6:30am-9am. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

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Events CALENDAR

NOVEMBER 12-13

NJ - EDISON — Computer Show. **LOCATION:** Raritan Center Exposition Hall, NJ Tpke. Exit #10, right after toll, follow signs into center. **HOURS:** Sat: 9:30am-4:30pm Sun: 10am-4pm. **FEATURES:** C. **DEALER INFO:** 1000+ tables. **CONTACT:** KGP Computer Show.*

NOVEMBER 13

CT - BRANFORD — Flea Market. **SPONSOR:** South-central Conn. ARA. **LOCATION:** Branford Intermediate School, 185 Damascus Rd. **HOURS:** 9am-7. **ADMISSION:** \$5. **TALK-IN:** 146.01/61. **FEATURES:** EX. **DEALER INFO:** Tables \$15 adv., \$20 door. Setup 7am. **CONTACT:** Info or reservations send SASE to: SCARA, POB 705, Branford CT 06405-0705. Info call: Brad, 203-265-9983 24 hrs.

FL - SAINT PETERSBURG — Computer Fair. **SPONSOR:** "We're Show Offs!" **LOCATION:** Best Western Mirage Hotel, 5005 34th St. N. (US 19 N). **HOURS:** 10am-3pm. **ADMISSION:** Adults \$4, \$3 w/ad, under 12 free. **FEATURES:** AC - C - DP - FP. **DEALER INFO:** \$40/1 table, \$75/2 tables, \$25/ea. add. **CONTACT:** "We're Show Offs!" 813-545-5265.

MA - DEDHAM — New England DX Convention. **SPONSOR:** Patriot DX Assn. & Southern New England DX Assn. **LOCATION:** VFW Post 2017, 84 Eastern Ave. **HOURS:** 10:30am-5pm. **TALK-IN:** 146.67. **CONTACT:** Tony Penta, WA1MWN, 617-334-3945 evenings.

MD - BOWIE — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Bowie State University, 1-295 (BW Parkway) to Rt. 197 S (Laurel-Bowie exit), follow signs. **HOURS:** 9:30am-4:30pm. **FEATURES:** C - FP. **DEALER INFO:** Setup 6:30am-9am. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

NH - PORTSMOUTH — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** Frank Jones Center, Exit 5 off I-95 to Rt. 1 Bypass South. **HOURS:** 10am-3:30pm. **ADMISSION:** \$7, 14 & under free w/adult. **FEATURES:** C. **DEALER INFO:** Setup 8am. **CONTACT:** Northern Computer Shows.*

PA - BUCKINGHAM — Swap Meet. **SPONSOR:** Delaware Valley Historical Radio Club. **LOCATION:** Tyro Grange Hall. **HOURS:** 8am-1pm. **CONTACT:** Mike Koste, 215-646-6488.

NOVEMBER 19

MA - BILLERICA — Amateur Radio & Electronics Auction. **SPONSOR:** Bull HN 1200 RC & Waltham ARA. **LOCATION:** Bull HN, 300 Concord Rd. **HOURS:** 10am-7. **ADMISSION:** Free. **TALK-IN:** 147.12+. **FEATURES:** FP - F/R. **DEALER INFO:** Seller check-in 9:30am (no junk, please). Commission 15%, \$1 min., \$30 max. **CONTACT:** Elliot Mayer, W1MJ, 508-851-0183. E-mail: 73210.3104@compuserve.com.

TN - COOKEVILLE — Cookeville Hamfest. **SPONSOR:** Cookeville Repeater Assn. & the Amateur Radio Society of Tennessee Tech. **LOCATION:** Hooper-Eblen Center Concourse on the Campus of TTU. **HOURS:** 8am-3pm. **ADMISSION:** \$3. **TALK-IN:** 147.21+. **DEALER INFO:** \$5 per table, call for reservations. **CONTACT:** TTARS, Box 5262, Cookeville TN 38505 or Rich King, KD4ABC, 615-528-7171.

NOVEMBER 19-20

FL - TAMPA — 19th Annual Suncoast Amateur Radio & Computer Convention. **SPONSOR:** Florida Gulf Coast Amateur Radio Council. **LOCATION:** Florida Expo Park, I-4 & US-301. **HOURS:** Sat: 9am-5pm, Sun: 9am-3pm. **ADMISSION:** \$5 adv., \$6 door, under 12 free. **TALK-IN:** 146.94, 223.98, 442.275, 51.72. **FEATURES:** CB - DP - EX - F - F/R - T. **DEALER INFO:** Swap tables \$20 for both days. Tailgating space \$5. **CONTACT:** Jean, 1556 56th Ave. N, St. Petersburg FL 33703. 813-525-5178 after 6pm.

MA - WILMINGTON — Computer Show. **LOCATION:** Shriner's, formerly Woburn, MA, N of Boston at I-93 Exit #39, right at bottom of ramp, follow signs. **HOURS:** Sat: 10am-4pm, Sun: 10am-3pm. **FEATURES:** C. **DEALER INFO:** 400 tables. **CONTACT:** KGP Computer Show.*

NY - LONG ISLAND — Ham Expo Weekend '94. **SPONSOR:** Radio Central ARC. **LOCATION:** University of NY at Stony Brook, Long Island Expwy. Exit 62, Nicolls Rd./Cnty. Rd #97 North. **HOURS:** 9am-4pm. **ADMISSION:** \$6 one day, \$10 two days. **FEATURES:** C - F - FM - F/R - H - S. **DEALER INFO:** Tables: \$20 one day, \$30 two days. **CONTACT:** John Mark, KB2QQ, 516-689-6343 or Emil Tillona, KD1F, 516-696-0610.

PA - KING OF PRUSSIA — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Valley Forge Convention Ctr. PA Turnpike to Exit 24. Take Exit 25 (Valley Forge National Park) to Rt. 363 N. Follow 1 mi. Convention Ctr. on right. **HOURS:**

9:30am-4:30pm. **FEATURES:** C - FP. **DEALER INFO:** Setup 6:30am-9am. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

NOVEMBER 20

NC - BENSON — JARSFEST '94. **SPONSOR:** Johnson ARS, Inc. **LOCATION:** American Legion Complex, Hwy. 301. **HOURS:** 8am-4pm. **ADMISSION:** \$4 adv., \$5 door, under 12 free w/adult. **TALK-IN:** 147.270+ 600. **FEATURES:** DP - EX - FP - T. **CONTACT:** Johnson Amateur Radio Society, Inc., POB 302, Benson NC 27504.

NOVEMBER 24

ME - LINCOLN — Hamfest. **LOCATION:** E. Burr Elementary School. **FEATURES:** EX. **CONTACT:** Darrell, N1LGX, 207-794-6445; Exams: Dave Baker, N1GOL, 207-794-3398.

NOVEMBER 25

NC - BUTNER — 3rd Annual Swapfest. **SPONSOR:** Falls Lake ARC. **LOCATION:** NC National Guard Armory. **FEATURES:** EX. **CONTACT:** Fred, KC4VSO, 919-575-4262.

NOVEMBER 25-26

GA - NORCROSS — Atlanta Area Computer Show. **LOCATION:** Cobb County Civic Center, 548 S. Marietta Pkwy. I-75 exit 112, Hwy 120 W. **HOURS:** Sat: 9am-5pm, Sun: 10am-4pm. **ADMISSION:** \$5 both days, \$4 Sun only. **FEATURES:** AC - C - DP - FP - F/R - RV-S. **DEALER INFO:** 8' tables \$35 for both days. **CONTACT:** Computer Show, POB 295, Riverdale GA 30274. 404-907-6225.

VA - ANNANDALE — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Nova. **HOURS:** 9:30am-4:30pm. **FEATURES:** C - FP. **DEALER INFO:** Setup 6:30am-9am. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

NOVEMBER 26

NH - SALEM — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** Rockingham Park, I-93 Exit 1, next to 175 Store Mall. **HOURS:** 10am-3:30pm. **ADMISSION:** \$7, 14 & under free w/adult. **FEATURES:** C. **DEALER INFO:** Setup 8am. **CONTACT:** Northern Computer Shows.*

NOVEMBER 26-27

NJ - PENNSAUKEN — Computer Show. **LOCATION:** South Jersey Expo Center (Cherry Hill), off NJ Tpke. Exit #4 on Route 73, minutes from downtown Philadelphia. **HOURS:** Sat: 10am-4pm Sun: 10am-3pm. **FEATURES:** C. **DEALER INFO:** 500+ tables. **CONTACT:** KGP Computer Show.*

NOVEMBER 27

MA - ROCKLAND — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** Sons of Italy, Rts. 123 & 139, Rt. 3, Exit 14 to Rockland Center. **HOURS:** 10am-3:30pm. **ADMISSION:** \$7, 14 & under free w/adult. **FEATURES:** C. **DEALER INFO:** Setup 8am. **CONTACT:** Northern Computer Shows.*

MD - BALTIMORE — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Martins West, Beltway at Security Blvd. 695 W towards Towson Exit 17 (Security Blvd.) to Rolling Rd. Cutoff at 1st intersection turn right on Belmont Ave., large white building on left. **HOURS:** 9:30am-4:00pm. **FEATURES:** C - FP. **DEALER INFO:** Setup 6:30am-9am. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

DECEMBER 3

FL - OCALA — Marion County Hamfest. **SPONSOR:** Marion County Repeater Owners Assn. **LOCATION:** Booster Stadium parking lot, NE 36th Ave. **HOURS:** 8am-4pm. **ADMISSION:** Sellers \$4, buyers free. **TALK-IN:** 146.970-Repeater. **FEATURES:** C - DP - E - FM - FP - F/R - H - RV-S - S - T. **DEALER INFO:** 904-245-9514. **CONTACT:** N4TSV, 904-245-9514.

ME - PORTLAND — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** Verrillo's Conv. Ctr., at Howard Johnson Motor Lodge, I-95 (Maine Turnpike) Exit 8. **HOURS:** 9:30am-2pm. **ADMISSION:** \$7, 14 & under free w/adult. **FEATURES:** C. **DEALER INFO:** Setup 8am. **CONTACT:** Northern Computer Shows.*

NC - GREENSBORO — 14th Annual Greater Greensboro Hamfest & Computer Show. **SPONSOR:** 76 Group. **LOCATION:** Greensboro Coliseum Complex Special Events Center, 1921 W. Lee St. **HOURS:** 9am-4pm. **ADMISSION:** \$5 adv., \$6 door, under 12 free. **TALK-IN:** 145.250. **FEATURES:** AC - C - CB - DP - E - EX - F - FM - F/R - H. **DEALER INFO:** Interior indoor flea market tables \$14, prime display area tables \$25. **CONTACT:** 76 Group, POB 7862, Greensboro, NC 27417-0862 or call REALTALK at 910-299-2525, Enter 0076 at prompt.

NJ - WAYNE — Computer Show. **LOCATION:** William Paterson College, Recreation Center, near I-80, Route 23 and Route 46. Call office for detailed directions. **HOURS:** 10am-4pm. **FEATURES:** C. **DEALER INFO:** 400+ tables. **CONTACT:** KGP Computer Show.*

DECEMBER 3-4

NJ - VOORHEES — PC Dealer Showcase. **SPONSOR:** StarWare. **LOCATION:** Echelon Mall, Rt. 295 Exit 31. **HOURS:** Sat: 10am-9:30pm, Sun: Noon-5pm. **ADMISSION:** Free. **FEATURES:** AC - C - FP. **DEALER INFO:** Tables \$95 ea. per day. **CONTACT:** StarWare, 610-584-8770.

DECEMBER 10

FL - FORT LAUDERDALE — Narlaam Computer Show. **SPONSOR:** Narlaam, Inc. **LOCATION:** Holiday Inn West, 5100 N State Rd. 7. **HOURS:** 9:30am-3:30pm. **ADMISSION:** \$5, \$4 w/ad, under 12 free. **FEATURES:** AC - C - FP. **CONTACT:** Narlaam.*

FL - ORLANDO — Computronics Fest. **SPONSOR:** "We're Show Offs!" **LOCATION:** Holiday Inn, 7900 S. Orange Blossom Trail. **HOURS:** 10am-3pm. **ADMISSION:** Adults \$4, \$3 w/ad, under 12 free. **FEATURES:** AC - C - DP - E - FP - H. **DEALER INFO:** Adv. tables \$30/1 table, \$55/2 tables, \$20/ea. add. table. After 11/26/94: \$50/1, \$80/2, \$25 ea. add. **CONTACT:** "We're Show Offs!" 813-545-5265.

MA - WESTPORT — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** White's Hospitality Ctr., Exit 9 E or 10 W off I-195. **HOURS:** 9:30am-2pm. **ADMISSION:** \$7, 14 & under free w/adult. **FEATURES:** C. **DEALER INFO:** Setup 8am. **CONTACT:** Northern Computer Shows.*

NJ - EDISON — Computer Show. **LOCATION:** Raritan Center Expo Hall, NJ Tpke. Exit #10, right at toll, follow signs to Raritan Center, near Staten Island. **HOURS:** 9:30am-4:30pm. **FEATURES:** C. **DEALER INFO:** 1000+ tables. **CONTACT:** KGP Computer Show.*

DECEMBER 10-11

GA - PERRY — Computer Show. **LOCATION:** Georgia National Fairgrounds & Agricenter, 401 Larry Walker Pkwy. **HOURS:** Sat: 9am-5pm, Sun: 10am-4pm. **ADMISSION:** \$5 both days, \$4 Sun only. **FEATURES:** AC - C - DP - FP. **DEALER INFO:** 8-ft tables \$35. **CONTACT:** POB 295, Riverdale GA 30274. 1-800-746-9001.

DECEMBER 11

FL - SAINT PETERSBURG — Computronics Fest. **SPONSOR:** "We're Show Offs!" **LOCATION:** Best Western Mirage Hotel, 5005 34th St. N. (US 19 N). **HOURS:** 10am-3pm. **ADMISSION:** Adults \$4, \$3 w/ad, under 12 free. **FEATURES:** AC - C - DP - E - FP - H. **DEALER INFO:** Adv. tables \$30/1 table, \$55/2 tables, \$20/ea. add. table. After 11/26/94: \$50/1, \$80/2, \$25 ea. add. **CONTACT:** "We're Show Offs!" 813-545-5265.

FL - WEST PALM BEACH — Narlaam Computer Show. **SPONSOR:** Narlaam, Inc. **LOCATION:** Palm Beach Airport Hilton, 150 Australian Ave. **HOURS:** 10am-4pm. **ADMISSION:** \$5, \$4 w/ad, under 12 free. **FEATURES:** AC - C - FP. **CONTACT:** Narlaam.*

NH - MANCHESTER — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** Center of NH Expo Complex at Holiday Inn, I-293 Exit 5 or 6. **HOURS:** 10am-3:30pm. **ADMISSION:** \$7, 14 & under free w/adult. **FEATURES:** C. **DEALER INFO:** Setup 8am. **CONTACT:** Northern Computer Shows.*

DECEMBER 17

MA - MARLBOROUGH — Computer Show. **LOCATION:** Royal Plaza Trade Center, near Boston, I-495 Exit #24-B, 1/2 mi. on right, 5 mi. N of Mass Tpke. **HOURS:** 10am-3pm. **FEATURES:** C. **DEALER INFO:** 500+ tables. **CONTACT:** KGP Computer Show.*

DECEMBER 18

NY - WHITE PLAINS — White Plains Computer Show & Sale. **SPONSOR:** Allied Expositions. **LOCATION:** Westchester County Center. **HOURS:** 10am-3pm. **FEATURES:** AC - C - FP. **DEALER INFO:** 2'x6' tables: First table \$35, \$25 ea. additional. Electricity is included at no extra charge when ordered in advance (\$10 surcharge on day of show). 200 tables. **CONTACT:** Allied Expositions, Inc., 44 Pinnacle Rock Rd., Stamford CT 06903. Tel: 203-329-2141, FAX: 203-322-1183.

JANUARY 7

NJ - PENNSAUKEN — Computer Show. **LOCATION:** South Jersey Expo Center, Off NJ Tpke. Exit #4 on Rt. 73. **HOURS:** 10am-4pm. **FEATURES:** C. **DEALER INFO:** 500+ tables. **CONTACT:** KGP Computer

Show.*

JANUARY 7-8

FL - FORT MYERS — Southwest Florida Hamfest '95. **SPONSOR:** Ft. Myers ARC. **LOCATION:** Ft. Myers Araba Shrine Temple, 2010 Hanson St., 1 block E of US 41. **HOURS:** Sat: 9am-5pm, Sun: 9am-3pm. **ADMISSION:** \$6 door. **TALK-IN:** 146.880-. **FEATURES:** AC - DP - EX - F - F/R. **DEALER INFO:** 8' tables \$15. **CONTACT:** Southwest Florida Hamfest '95, FMARC, POB 61183, Ft. Myers FL 33901.

JANUARY 14

PA - LANCASTER — Dutch Country Computer & Communications Show. **SPONSOR:** Columbia Area ARC. **LOCATION:** Lancaster Host Resort & Conference Center, Rt. 30 East. **HOURS:** 9am-2pm. **ADMISSION:** \$5, under 12 free. **TALK-IN:** 146.715. **FEATURES:** C - CB - EX - FP - H - T. **CONTACT:** Dutch Country Computer & Communications Show, POB 682, East Petersburg PA 17520. Ph: 717-560-2072 (exhibitors only) or FAX: 717-872-0857.

JANUARY 14-15

AL - HUNTSVILLE — Computer Show. **LOCATION:** Von Braun Civic Center, 700 Monroe St. Exit 19-C off I-565. **HOURS:** Sat: 9am-5pm, Sun: 10am-4pm. **ADMISSION:** \$5 both days, \$4 Sun only. **FEATURES:** AC - C - DP - F/R - RV-S. **DEALER INFO:** 8-ft tables \$45. **CONTACT:** Computer Show, POB 295, Riverdale GA 30274. 404-907-6225, 800-746-7001.

FL - SARASOTA — Sarasota Hamfest & Computer Show. **LOCATION:** Roberts Sports Arena, Sarasota Fairgrounds, 3000 Ringling Blvd. **ADMISSION:** \$5 adv., \$7 door. **TALK-IN:** 146.31/91, 444.925, 146.13/73. **FEATURES:** DP - EX - F - FP - F/R - RV-H - T. **DEALER INFO:** Regular tables \$15 plus admission, booths & end tables \$20. Tailgating \$5 per space plus admission. **CONTACT:** Sarasota Hamfest, c/o Ed Neely, 2632 Sunnyside St., Sarasota FL 34239. 813-366-5564.

MA - MARLBOROUGH — Computer Show. **LOCATION:** Royal Plaza Trade Center, I-495 Exit #24-B, 1/2 mi. on right, 5 mi. N of Mass Tpke. **HOURS:** Sat: 10am-4pm, Sun: 10am-3pm. **FEATURES:** C. **DEALER INFO:** 500+ tables. **CONTACT:** KGP Computer Show.*

JANUARY 15

NY - YONKERS — Giant Electronic Fleamarket. **SPONSOR:** Metro 70cm Network. **LOCATION:** Lincoln High School, Kneeland Ave. **HOURS:** 9am-3pm rain or shine. **ADMISSION:** \$5, under 12 free. **TALK-IN:** 440.425R, 445.425T, PL156.7. **FEATURES:** DP - EX - FP - F/R. **DEALER INFO:** \$18 1st table, \$13 ea. additional in adv. All tables \$25 at door. **CONTACT:** Otto Supliski WB2SLQ, 914-969-1053.

JANUARY 18-19-20-21

FL - ORLANDO — Home Systems Training. **SPONSOR:** Home Systems Plus. **CONTACT:** HSP, 410-356-HOME.

JANUARY 21

FL - FORT LAUDERDALE — Narlaam Computer Show. **SPONSOR:** Narlaam, Inc. **LOCATION:** Holiday Inn West, 5100 N State Rd. 7. **HOURS:** 9:30am-3:30pm. **ADMISSION:** \$5, \$4 w/ad, under 12 free. **FEATURES:** AC - C - FP. **CONTACT:** Narlaam.*

JANUARY 21-22

NJ - HACKENSACK — Computer Show. **LOCATION:** Fairleigh Dickinson Univ., Rothman Center, Rt. 4 to Hackensack Ave. S, left at Temple Ave. traffic light, near GW Bridge. **HOURS:** Sat: 10am-4pm, Sun: 10am-4pm. **FEATURES:** C. **DEALER INFO:** 500+ tables. **CONTACT:** KGP Computer Show.*

JANUARY 22

FL - WEST PALM BEACH — Narlaam Computer Show. **SPONSOR:** Narlaam, Inc. **LOCATION:** Palm Beach Airport Hilton, 150 Australian Ave. **HOURS:** 10am-4pm. **ADMISSION:** \$5, \$4 w/ad, under 12 free. **FEATURES:** AC - C - FP. **CONTACT:** Narlaam.*

JANUARY 28-29

NC - CHARLOTTE — Charlotte Area Computer Show. **LOCATION:** Metrolina Expo Center. **HOURS:** Sat: 9am-5pm, Sun: 10am-4pm. **ADMISSION:** \$5 both days, \$4 Sun. only. **FEATURES:** AC - C - DP - FP. **DEALER INFO:** 8-ft tables \$35. **CONTACT:** Computer Show, POB 295, Riverdale GA 30274. 800-746-9001.

PA - FORT WASHINGTON — Computer Show. **LOCATION:** Ft. Washington Expo Center, near Philadelphia, PA Tpke. Exit #26, 1/2 mi. to light, turn right and follow signs. **HOURS:** Sat: 10am-4pm, Sun: 10am-3pm. **FEATURES:** C. **DEALER INFO:** 500+ tables. **CONTACT:** KGP Computer Show.*

Events CALENDAR

JANUARY 29

MD - ODENTON — Post Holiday Swapfest & Flea Market. **SPONSOR:** Maryland Mobileers ARC. **LOCATION:** Odenton Fire Hall, 1425 Annapolis Rd. (MD Rt. 175). **HOURS:** 8am-2pm. **ADMISSION:** \$3. **TALK-IN:** 146.205/805. **FEATURES:** AC - EX - FM - F/R - H. **DEALER INFO:** Tables \$7 adv. **CONTACT:** Tom Wilkison, KA3OMU, 592 Eason Dr., Severn MD 21144. 410-969-2639 evenings.

Month At A Glance

NOVEMBER 1994

NOVEMBER 5

AZ - Tempe - Arizona Antique Radio Club Swap Meet
CA - Fresno - MarketPro Computer Show*
CA - Santee - Santee Swap Meet
FL - Eustis - Lake County Hamfest & Electronics Expo
IN - Indianapolis - AGI Computer Fairs*
MD - New Carrollton - CMA Computer Shows
MI - Roseville - Int'l Canadian/American Mega-Fest Show
MI - Taylor - Computers & You Computer Show
NH - Nashua - Northern Computer Shows & Sales*
NJ - Hightstown - NJ Antique Radio Club Fall Meet/Auction
OK - Enid - Enid Hamfest Group Hamfest
TX - Sulphur Springs - Hopkins County ARC Fall Hamfest
WA - Bellingham - Mount Baker ARC Flea Market
WI - Waukesha - Milwaukee Repeater Club Friendlyfest

NOVEMBER 5-6

CA - Sacramento - MarketPro Computer Show*
FL - Miami - EDG Enterprises COM/BUS Computer/Elec Show
GA - Lawrenceville - Alford Memorial RC Hamfest
OH - Cincinnati - Trade Show Productions Computer Fair
PA - Easton - StarWare PC Dealer Showcase
PA - Ft. Washington - KGP's Computer Show*
TX - Odessa - West Texas ARC Hamfest Convention

NOVEMBER 6

CA - Livermore - Livermore ARC Swap Meet
CA - Oxnard - MarketPro Computer Show*
IN - Anderson - AGI Computer Fairs*
KY - Louisville - Meka Enterprises Computer Fair South
MA - Taunton - Northern Computer Shows & Sales*
MI - Madison Heights - Computers & You Computer Show
MI - Southfield - Oak Park ARC Swap & Shop
MI - Taylor - Int'l Canadian/American Mega-Fest Show
MO - Carthage - Carthage ARS Hamfest
NC - Concord - Cabarrus ARS Hamfest/Swap Meet
OH - Cleveland - National Expo's Computer Mania
WI - Kaukauna - Fox Cities ARC Ham & Computer Fest

NOVEMBER 11

NJ - Fairlawn - Fairlawn ARC Ham/Computer Auction

NOVEMBER 12

AL - Montgomery - Montgomery ARC Hamfest/Computer
CA - Fontana - Inland Empire ARC Swap Meet
CA - Santa Rosa - MarketPro Computer Show*
FL - Hialeah - Hialeah Adult Center Hamfest
FL - Lake Worth - Sunset Ridge Park Hamfest
FL - Orlando - We're Show Offs Computer Show
LA - West Monroe - Twin Cities Ham Club Hamfest
MA - Plymouth - Mayflower ARC Flea Market
MI - Kalamazoo - Computers & You Computer Show
OR - Hillsboro - NorthWest Computer Show & Sale
PA - Hershey - Central Penna. Repeater Assn. Hamfest
SC - Myrtle Beach - Grand Strand ARC Hamfest/Computer
VA - Manassas - MarketPro Computer Show & Sale

NOVEMBER 12-13

CA - Westwood - American Mega Shows Computer Show
NJ - Edison - KGP's Computer Show*

NOVEMBER 13

CA - Lancaster - MarketPro Computer Show*
CA - San Rafael - MarketPro Computer Show*
CO - Denver - CO Radio Collectors Swap Meet/Meeting
CT - Branford - Southcentral Conn. ARA Flea Market
FL - St. Petersburg - We're Show Offs Computer Show
MA - Dedham - New England DX Convention
MD - Bowie - MarketPro Computer Show & Sale
MI - Dearborn - Computers & You Computer Show
NH - Portsmouth - Northern Computer Shows & Sales*
PA - Buckingham - Del Valley Historical Radio Club Swap

NOVEMBER 19

CA - Santee - Santee Swap Meet
IN - Merrillville - Computer Possibilities Unlimited
MA - Billerica - Bull HN 1200 RC/Waltham ARA Auction
MI - Holland - Holland ARC Hamfest/Computer Expo
MI - Livonia - Computers & You Computer Show
MI - Roseville - Int'l Canadian/American Mega-Fest Show
NM - Socorro - Socorro ARA, Tech ARA Hamfest
TN - Cookeville - Cookeville Repeater Assn. Hamfest
VA - Tysons Corner - CMA Computer Shows

NOVEMBER 19-20

FL - Tampa - Suncoast Amateur Radio/Computer Convent
IN - Ft. Wayne - Hamfest/Computer Expo/IN State Convnt
MA - Wilmington - KGP's Computer Show*
NY - Long Island - Radio Central ARC Ham Expo Weekend
PA - King of Prussia - MarketPro Computer Show & Sale

NOVEMBER 20

AZ - Phoenix - Computer & Electronic Swap Meet
CA - Stockton - MarketPro Computer Show*
IL - Chicago - Chicago ARC Surplus Electronic Auction
IL - Orland Park - The Orland Park Computer Show
MI - Flint - Computers & You Computer Show
MI - Taylor - Int'l Canadian/American Mega-Fest Show
NC - Benson - Johnson ARS JARSFEST '94
OH - Cleveland - National Expo's Computer Mania

NOVEMBER 25-26

GA - Marietta - Atlanta Area Computer Shows
VA - Annandale - MarketPro Computer Show & Sale

NOVEMBER 26

CA - Vallejo - MarketPro Computer Show*
IL - Litchfield - Central IL Television Banquet

IN - Evansville - E.A.R.S. Winter Hamfest
MI - Waterford - Computers & You Computer Show
MI - Westland - Great Lakes Computer Expo & Sale
NH - Salem - Northern Computer Shows & Sales*

NOVEMBER 26-27

CA - San Diego - MarketPro Computer Show*
NJ - Pennsauken - KGP's Computer Show*

NOVEMBER 27

CA - Sacramento - MarketPro Computer Show*
CA - Santa Ana - ACP Swap Meet
IL - Glen Ellyn - Computer Central Computer Show
IL - Wheaton - GMRS of Illinois Winterfest
MA - Rockland - Northern Computer Shows & Sales*
MD - Baltimore - MarketPro Computer Show & Sale
MI - Flint - Five Star Productions Computer Trade Show
MI - Southfield - Support Services Computer Festival
MI - Southgate - Computers & You Computer Show

DECEMBER 1994

DECEMBER 3

AZ - Mesa - Superstition ARC Hamfest '94
CA - Santa Rosa - MarketPro Computer Show*
CA - Santee - Santee Swap Meet
CA - Ventura - MarketPro Computer Show*
FL - Ocala - Marion County Repeater Owners Hamfest
IN - Indianapolis - AGI Computer Fairs*
MD - New Carrollton - CMA Computer Shows
ME - Portland - Northern Computer Shows & Sales*
MI - Roseville - Int'l Canadian/American Mega-Fest Show
NC - Greensboro - 76 Group Hamfest & Computer Show
NJ - Wayne - KGP's Computer Show*
OH - North Olmsted - North Coast ARC Fall Hamfest

DECEMBER 3-4

NJ - Voorhees - StarWare PC Dealer Showcase

DECEMBER 4

CA - Lancaster - MarketPro Computer Show*
CA - Livermore - Livermore ARC Swap Meet
MI - Grand Rapids - Computers & You Computer Show
MI - Hazel Park - Hazel Park ARC 29th Annual Swap & Shop
MI - Taylor - Int'l Canadian/American Mega-Fest Show
OH - Canton - Canton Computer Festival

DECEMBER 10

CA - Fontana - Inland Empire ARC Swap Meet
FL - Ft. Lauderdale - Narisaam Computer Shows*
FL - Orlando - We're Show Offs Computer Show
IL - Jacksonville - Central Illinois Winter Superfest
MA - Westport - Northern Computer Shows & Sales*
MN - Faribault - Handi-Ham Winter Hamfest
NJ - Edison - KGP's Computer Show*

DECEMBER 10-11

CA - Sacramento - MarketPro Computer Show*
GA - Perry - Atlanta Area Computer Show

DECEMBER 11

FL - St. Petersburg - We're Show Offs Computer Show
FL - West Palm Beach - Narisaam Computer Shows*
IN - Greenfield - Hancock ARC Greenfield Hamfest
NH - Manchester - Northern Computer Shows & Sales*
OH - Cleveland - Computer Mania Computer Show

DECEMBER 17

CA - Santee - Santee Swap Meet
IN - Merrillville - Computer Possibilities Unlimited
MA - Marlborough - KGP's Computer Show*
MI - Roseville - Int'l Canadian/American Mega-Fest Show
MI - Westland - Great Lakes Computer Expo & Sale
OH - Cleveland - Computer Mania Computer Show

DECEMBER 17-18

CA - Del Mar - MarketPro Computer Show*
CA - Northridge - American Mega Shows Computer Show
CA - Oxnard - MarketPro Computer Show*
CA - Vallejo - MarketPro Computer Show*

DECEMBER 18

IL - Orland Park - The Orland Park Computer Show
MI - Flint - Five Star Productions Computer Trade Show
MI - Taylor - Int'l Canadian/American Mega-Fest Show
NY - White Plains - Allied Expositions Computer Show/Sale
OH - Akron - Computer Mania Computer Show
OH - Bowling Green - CDE Computer Products Show
OH - Toledo - Computer Blowout Super Show & Sale
VA - Tysons Corner - CMA Computer Shows

JANUARY 1995

JANUARY 1

CA - Livermore - Livermore ARC Swap Meet

JANUARY 7

NJ - Pennsauken - KGP's Computer Shows*

JANUARY 7-8

FL - Ft. Myers - Ft. Myers ARC Southwest Florida Hamfest

JANUARY 8

WI - Waukesha - West Allis RAC Midwinter Swapfest

JANUARY 14

PA - Lancaster - Columbia Area ARC Communication Show

JANUARY 14-15

AL - Huntsville - Atlanta Area Computer Show
FL - Sarasota - Sarasota Hamfest & Computer Show
MA - Marlborough - KGP's Computer Shows*

JANUARY 15

AZ - Phoenix - Computer & Electronic Swap Meet
NY - Yonkers - Metro 70cm Network Electronic Flea Market

JANUARY 18-19-20-21

FL - Orlando - Home Systems Plus Training

JANUARY 21

CO - Loveland - Northern CO ARC Superfest Swap Meet
FL - Ft. Lauderdale - Narisaam Computer Show*
LA - Hammond - Southeast Louisiana ARC Hamfest
MO - St. Joseph - Missouri Valley ARC Winter Hamfest

JANUARY 21-22

NJ - Hackensack - KGP's Computer Shows*

JANUARY 22

FL - West Palm Beach - Narisaam Computer Show*
IL - Glen Ellyn - Computer Central Computer Show

JANUARY 28-29

NC - Charlotte - Charlotte Area Computer Show
PA - Ft. Washington - KGP's Computer Shows*

JANUARY 29

MD - Odenton - Maryland Mobileers ARC Swapfest
OH - Dover - Tusco ARC Hamfest

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HighText Publications, Inc.	42	Video Connection, Inc.	7
HoopsWare.....	29	Videospectra.....	90
H.T. Orr Computer Supplies.....	138	Vision Distributors.....	50
Index Publishing Group, Inc.	15	Visitect, Inc.	87
Information Unlimited.....	137	Visual Communications, Inc.	84
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Intronics, Inc.	116	Wholesale Cable.....	67
J & D Electronics.....	95	Windward Products.....	119
J & J Surface.....	125	Xandi Electronics.....	118

▶▶▶▶▶ USE THE CLASSIFIEDS !! ◀◀◀◀◀

READ BY 80,000 QUALIFIED ELECTRONIC BUYERS, SELLERS AND TRADERS EVERY MONTH!

HOW TO USE THE CLASSIFIEDS

TYPE or PRINT your "electronically related" ad copy **CLEARLY (not all caps)** on the form provided or on a separate piece of paper. Calculate the number of words and multiply it by the appropriate rate (see DETERMINING YOUR RATE PER WORD section). Include any charges for **Bold** and/or **CAPPED** words, any photo costs that would be applicable and/or costs for boxing your ad (explained below). Choose the appropriate classification for your ad(s) to appear in (see right). Enclose your name, address and account number (if available) for identification purposes. Include full payment — **CLASSIFIEDS ARE RUN ON A PRE-PAID BASIS ONLY** — and mail your completed order to:

NUTS & VOLTS MAGAZINE
430 Princeland Court
Corona, CA 91719

DETERMINING YOUR RATE PER WORD

The ad rate for **current PAID subscribers** is 30¢ per word. **All others** pay 60¢ per word. These rates apply to the first 150 words of your ad. From 151-200 words, the rate per word doubles to 60¢ and \$1.20 respectively. We do not accept ads over 200 words. There is a \$4.50 minimum charge per ad per insertion.

ADDING PHOTOS, DRAWINGS OR BOXES

A photo or drawing may be run at the top of your classified ad for an additional **\$10.00 (one inch max.)** for camera ready art. No wording is allowed in this area. Add a one-time charge of **\$5.00** to enlarge or reduce line art or **\$8.00** for halftone of photographs. To **BOX** your ad, include an **additional \$25** for copy-only ads **OR \$50** for ads with artwork or photos.

USING BOLD AND/OR CAPS IN YOUR AD

Words to be set in **bold** or **CAPS** are each 10¢ extra PER WORD. **BOLD CAPS** are 20¢ extra per word. Indicate bold words by Underlining. Words normally written in caps (e.g., IBM) and accepted abbreviations such as VAC or MHz are NOT charged as all cap words. Use a 2-letter abbreviation for states (e.g., Ohio = OH). A phone number is one word. It will be most helpful if you would spell out words when submitting handwritten copy.

WHEN YOUR AD WILL BE PRINTED

Ads received **BY** our closing date (the 10th of the month) will run the following month. **EX:** Ads received by May 10th will run in June. Ads postmarked through May 10th but received after the closing date will be placed in the next available issue. No cancellations or changes after the 10th.

SOME THINGS YOU SHOULD KNOW BEFORE SUBMITTING A CLASSIFIED AD

The **first two words** of your ad will be set in **BOLD CAPS** at **no charge**. Running copy only. No special positioning, centering, dot leaders, extra space, etc. is allowed. All advertising in Nuts & Volts is limited to electronically related items **ONLY**. All ads are subject to approval by the publisher. We reserve the right to reject or edit any ad submitted. We do not take ad copy or changes over the phone. The magazine is mailed on or before the 1st of the month. We do not bill for classified ads. Repeat ads or ads run in multiple classifications within the same issue are allowed. Paid subscribers may run ads at the 30¢ rate only through their subscription expiration date.

FAXING IN AD COPY

You may fax in ad copy or changes to Nuts & Volts before the closing date (the 10th) at 909-371-3052 using a MasterCard or Visa. Be sure to include the credit card expiration date, the name that appears on the card and a daytime phone number. Ads faxed in without credit card information will not be printed until payment is received in full. For verification of faxed-in ads, call 909-371-8497.

CHOOSING A CLASSIFICATION

Select the appropriate classification for your ad(s) to appear in and mark it in the space provided below. If no classification is indicated, the ad(s) will be placed in the Miscellaneous Section or wherever we deem most suitable. Available classifications to choose from are:

- | | |
|-------------------------------|---|
| 10. Ham Gear For Sale | 115. Telephone - Fax |
| 20. Ham Gear Wanted | 120. Components |
| 30. CB - Scanners | 130. Antique Electronics |
| 40. Music & Accessories | 140. Publications |
| 50. Computer Hardware | 150. Plans - Kits - Schematics |
| 60. Computer Software | 155. Manuals - Schematics Wanted |
| 70. Computer Equipment Wanted | 160. Miscellaneous Electronics For Sale |
| 80. Test Equipment | 170. Miscellaneous Electronics Wanted |
| 85. Security | 180. Education |
| 90. Satellite Equipment | 190. Business Opportunities |
| 100. Audio - Video - Lasers | 200. Repairs - Services |
| 110. Cable TV | |

PLEASE TYPE or PRINT CLEARLY — ONE WORD PER SPACE—

AD #1 — CLASSIFICATION # _____

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_____	x	_____	=	_____	+	_____	+	_____	=	_____	x	_____	=	_____
Total Words														
	<input type="checkbox"/> 30¢ Paid Sub or			Subtotal		<input type="checkbox"/> Bold/Caps and/or		BOX IT!		Subtotal		No. of Issues		Total
	<input type="checkbox"/> 60¢ Non Sub					<input type="checkbox"/> Art/Photo		<input type="checkbox"/> \$25 copy only						
								<input type="checkbox"/> \$50 copy/art						

AD #2 — CLASSIFICATION # _____

_____	_____	_____	_____
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_____	x	_____	=	_____	+	_____	+	_____	=	_____	x	_____	=	_____
Total Words														
	<input type="checkbox"/> 30¢ Paid Sub or			Subtotal		<input type="checkbox"/> Bold/Caps and/or		BOX IT!		Subtotal		No. of Issues		Total
	<input type="checkbox"/> 60¢ Non Sub					<input type="checkbox"/> Art/Photo		<input type="checkbox"/> \$25 copy only						
								<input type="checkbox"/> \$50 copy/art						

Account Number _____ Total Enclosed _____

REMEMBER: All Ads Must Be PREPAID. \$4.50 min. per ad per insertion. Classified ads will not be processed until payment is complete. No refunds. Credit only.

B&S SALES

CALL (810) 566-7248 • FAX (810) 566-7258 24 hrs.

Hours: Monday through Friday 8am to 7:30pm EST – Saturday 10am to 3pm.
51756 Van Dyke St. #330, Shelby Township, MI 48316

Free Calculator with order!

WE WILL BEAT
OR MATCH ANY
PRICE IN THIS
MAGAZINE

CONVERTER

	5	10		5	10
PANASONIC TZ-PC 145362..	\$68	\$64	DRX-3 PJ	\$37	\$33
WAVEMASTER	\$65	\$60	DRZ-3 PJ	\$38	\$34
DRZ-3 A & B DUAL INPUT	\$39	\$35	8528 PJ	\$45	\$42

CONVERTER/DESCRAMBLERS

	5	10		5	10
8600	\$275	\$265	DPV-5	\$145	\$130
8590	\$260	\$250	DP-5	\$125	\$110
8580	\$195	\$185	DRZ-3-DIC	\$95	\$85
DPV-7	\$225	\$215	DRX-3-DIC	\$89	\$79

ADD-ON DESCRAMBLERS

10 LOT SPECIAL

PIONEER GREEN	\$65	J-TVT-GOLD	\$42
SA-M80	\$65	J-MINI TVT	\$42
J-TNT	\$65	H-MLD 1200-3	\$35
J-PURPLE	\$49		

NOTE: MENTION AD FOR THESE PRICES!

NO MICHIGAN SALES

We are now offering a 6-month warranty. In order for warranty to be in effect, this form must be signed and returned. FOR VCR, SECOND, THIRD, ETC. HOOK-UPS.

☐ Yes, I agree all units are to be used or resold in compliance with Federal and State laws.

Signature _____ Date _____

NAME _____ ADDRESS _____

CITY _____ STATE _____ ZIP _____ PHONE _____

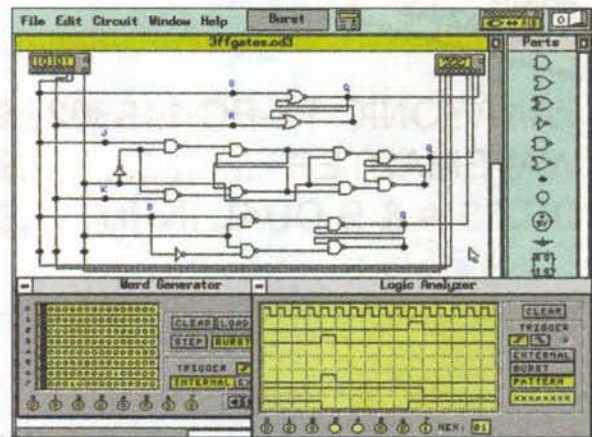
It is not the intent of B&S Sales to defraud any pay television operator and we will not assist any company or individual in doing the same.

"Design work is faster and cheaper
with Electronics Workbench."

Mark Weaver

Production Engineer Technician
Colorado Memory Systems/HP

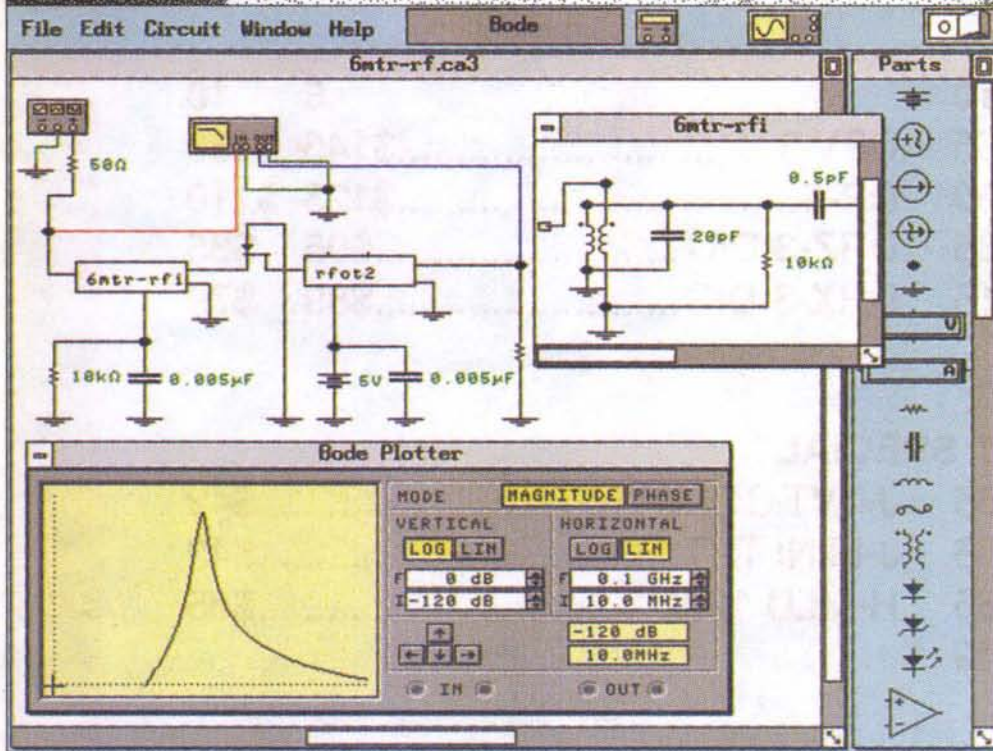
Electronics Workbench is a highly productive bench where you design and verify circuits in a fraction of the time. Connections are always perfect. Wires route themselves. And the simulated components and test instruments work just like the real thing.



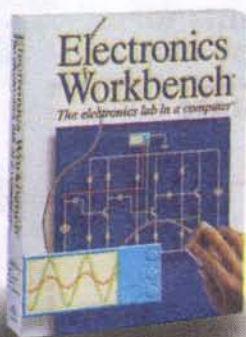
Digital Module: Analyzing a logic circuit.

It's faster than building with actual components because you change connections and component values instantly. And since the simulated components are free, you don't need to replace burnt-out parts or keep an extensive inventory. The result: You save precious time and money. Guaranteed!*

The standard for simplicity and power for over six years, Electronics Workbench is the most popular tool of its kind. It has gained worldwide acclaim as the ideal complement to any test bench. **Fact: Over 90% of our customers recommend it to their friends and colleagues.**



Analog Module: Tuning an RF front end.



Just \$299*

For DOS, Windows or Mac Version.

150 November 1994/Nuts & Volts Magazine



Electronics Workbench®

The electronics lab in a computer™

Call: 800 263-5552

INTERACTIVE IMAGE TECHNOLOGIES LTD.
908 Niagara Falls Blvd. #068, North Tonawanda, NY 14120-2060
Telephone: (416) 361-0333 FAX: (416) 368-5799

*30-day money-back guarantee.

Prices in U.S. dollars, shipping \$15. Offer valid in U.S. and Canada only.
All trademarks are the property of their respective owners.

Write in 121 on Reader Service Card.





STOP!

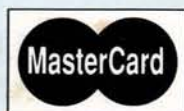
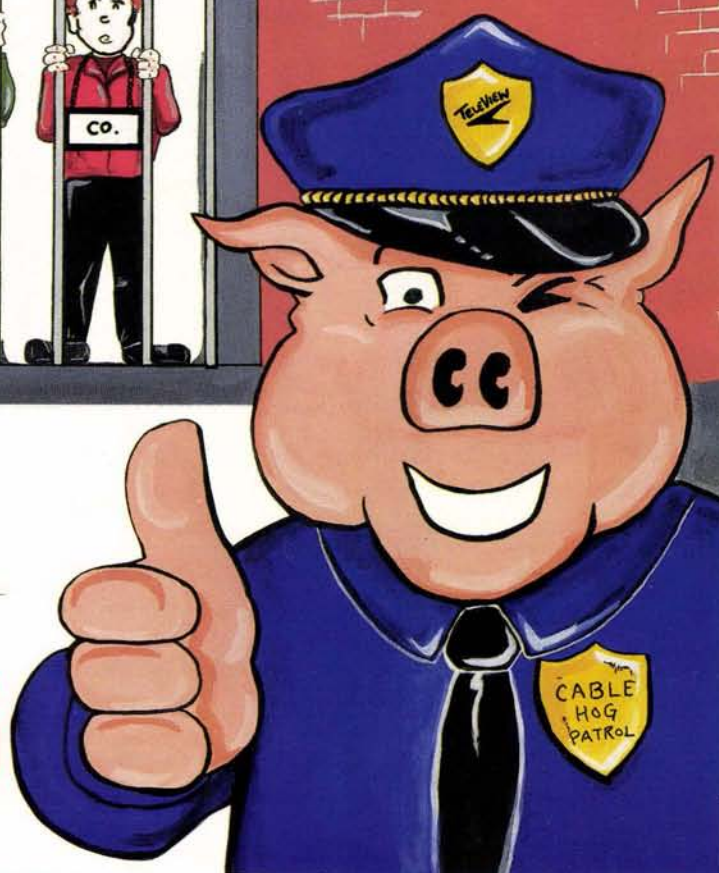
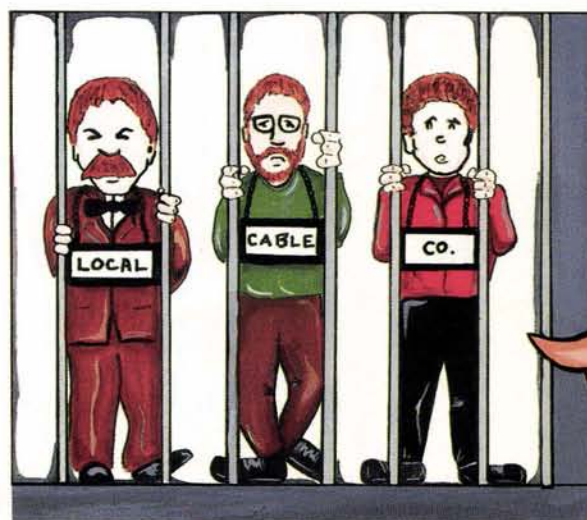
**Is Your Cable
Company
Robbing You
Blind?**

**STOP
CABLE
THEFT.**

CALL

1-800-225-3105

TELEVIEW

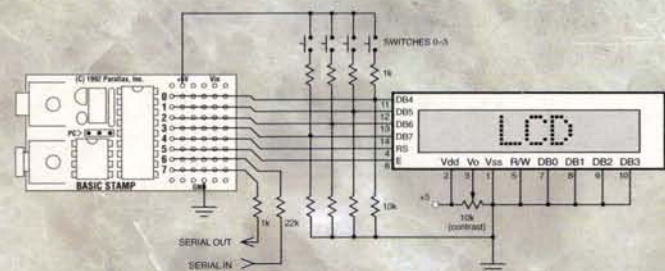


BASIC STAMP™

Stamp Computer Runs BASIC

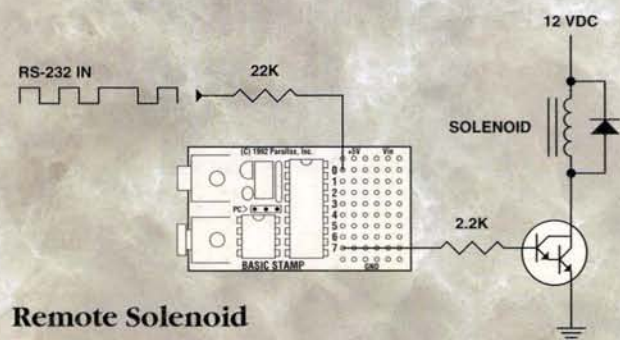
The BASIC Stamp is a 1.5x2.5-inch computer that runs BASIC programs written on your PC. It has 8 I/O lines, which can easily be programmed for serial communications, potentiometer input, pulse measurement, button debounce, tone generation, PWM, etc. And all by just adding a resistor and/or capacitor, if anything.

The circuits on this page show some of the things our customers are doing with Stamps.



Micro-Terminal

In this application, the Stamp receives serial data and displays it on the LCD. The state of the four buttons is then transmitted serially.



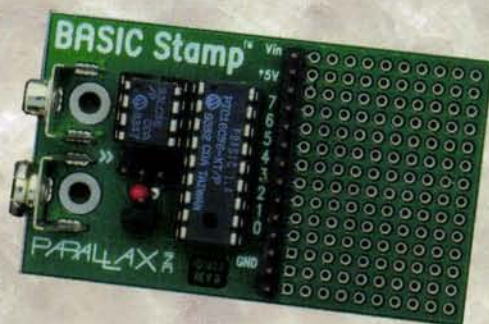
Remote Solenoid

Here, the Stamp monitors a serial line and waits for a specific code. If the code is received, then the Stamp activates the solenoid.



Stamp Programming Package

\$99



Stamps sell for \$39, and lower prices start at just four units.

Writing programs for the Stamp is easy. The BASIC Stamp Programming Package contains everything you need to program Stamps using your PC. The package includes our editor software, programming cable, manual, application notes, and free technical support. The package is available for \$99 (please note: Stamps are sold separately).

PARALLAX™

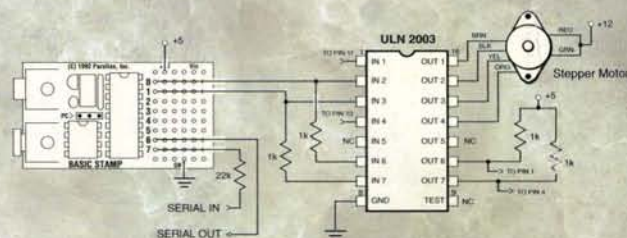
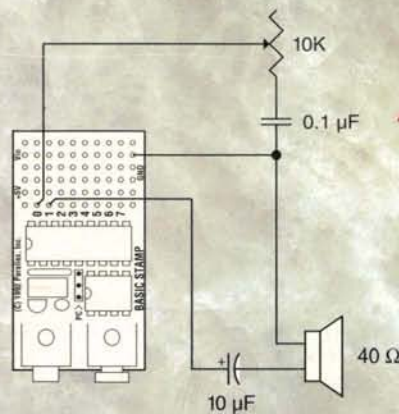
3805 Atherton Road, #102 • Rocklin, CA 95765 • USA
(916) 624-8333 • Fax: 624-8003 • BBS: 624-7101

BASIC Stamp and the Parallax logo are trademarks of Parallax, Inc. • Features and prices subject to change without notice. • Prices are U.S. prices only; prices in other countries may vary.



Noise Maker

In this application, the Stamp reads the pot and outputs a variable tone or white noise.

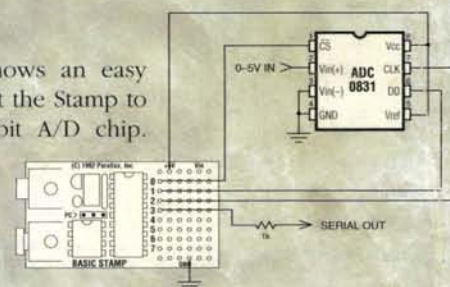


Stepper Motor Controller

This circuit makes the Stamp into a remote stepper motor controller. Using serial communications, the Stamp sends out a request for number of steps and delay between each. When it receives the data, the Stamp steps the motor as directed.

Serial A/D

This circuit shows an easy way to connect the Stamp to a common 8-bit A/D chip.



NEW

BS1-IC

New Stamp Module Available Soon

A number of customers have expressed interest in a SIP-type Stamp for use in their products. So, we designed the "BS1-IC" depicted above (actual size). The BS1-IC has the same functions as the original Stamp, but without the prototype area and battery clips. We should have production units in November, depending upon availability of surface-mount parts. Pricing will start at \$29.



0894NV

NUTS & VOLTS MAGAZINE
430 PRINCELAND COURT
CORONA, CA 91719

FWD & ADDRESS CORRECTION REQUESTED